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Original article

Outcome of prolonged balloon inflation for the management of coronary perforation

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ABSTRACT

Background: Coronary perforation (CP) is a rare, sometimes lethal complication of percutaneous coronary intervention (PCI).
Objectives: The purpose of this study was to review the cases of CP and to investigate the management after CP.
Methods: A total of 3469 PCIs were performed in our institution from April 1999 to April 2008. All CP cases were identified from our computerized database.
Results: Thirty patients were identified as having CP (0.86%). According to the Ellis classification, we determined the grade of perforation as type I in 17 cases (56%), type II in 2 cases (7%), and type III in 11 cases (37%). Most CPs were caused by wires (53%), while balloons, stents, and atherectomy devices were responsible for 7%, 37%, and 3%, respectively. Wire caused only 1 case of type III CP (6%), while stent caused 9 type III CPs (82%, $p < 0.01$). Four patients (36%) with type III CP required urgent coronary artery bypass graft surgery (CABG), while no patient with type I/II CP required it ($p < 0.01$). Prolonged balloon inflations were effective for 8 cases out of 11 stent CPs, however, the ballooning duration was significantly longer than that in wire and balloon CP (44 ± 37 min vs. 21 ± 13 min, $p < 0.05$).
Conclusions: Stent CP often causes type III CP and one third of type III CP required urgent CABG. Although stent CP required longer balloon inflations for the management, prolonged balloon inflation might be useful for the management even in the stent CP.

Introduction

Coronary perforation (CP) with percutaneous coronary intervention (PCI) occurs only rarely, but sometimes is a lethal complication [1–5]. There is no consensus about the optimal treatment of patients with CP; commonly used treatment options include prolonged balloon inflation, placement of a covered stent graft (CSG), pericardiocentesis, or urgent coronary artery bypass graft (CABG) surgery. CP is one of the indications for emergent CABG, however, urgent CABG in CP is associated with high mortality [6].

Although the CSG may be a reliable and highly effective treatment option for sealing CPs complicating PCIs [7], CSG does not have good prognosis in middle-term outcomes [8,9]. Besides, no studies about the usefulness of prolonged balloon inflation for CP have been reported.

The purpose of this study is to gain information about the incidence, management, and outcome of CP and to investigate the effectiveness and feasibility of prolonged balloon inflation for the management of CP in the contemporary era.

Materials and methods

Data from all patients who had CP as a complication of PCI at our institution from April 1999 to April 2008 were analyzed retrospectively from our computerized database. The type of perforation was classified according to the criteria proposed by Ellis et al. [1]. Type I CP is defined by the development of an extraluminal crater without extravasation, type II CP by a pericardial or myocardial blush without contrast jet extravasation, and type III CP by extravasation through a perforation of a cavity spilling into an anatomic cavity. All patients received dual antiplatelet therapy, aspirin 81–100 mg and clopidogrel 75 mg once a day or aspirin 81–100 mg once a day and ticlopidine 200 mg twice a day orally. Heparin bolus of 100 units/kg body weight was initially given. Periodic IV bolus of heparin was also given to keep activated clotting time value between 250 and 350 s throughout the procedure. No GP IIb/IIIa inhibitor was used in

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our institution. This study was approved by our hospital's Human Clinical Study Committee.

All descriptive data are expressed as the mean ± SD and Student's *t*-test was used to compare the variables. Categorical variables were compared using Fisher's exact test. A value of $p < 0.05$ was considered statistically significant. All calculations were performed using SPSS 19 software (SPSS Inc., Chicago, IL, USA).

Results

A total of 3469 interventions were performed at our institution during the study period. We identified 30 patients with CP (0.86%). According to the Ellis classification, we determined the grade of perforation as type I CP in 17 cases (56%), type II CP in 2 cases (7%), and type III CP in 11 cases (37%) as shown in Table 1. No death was recorded among these cases in any grade of CP. Most cases of CP were caused by wires (16 cases, 53%), while balloons, stents, and atherectomy devices were responsible for 2 cases (7%), 11 cases (37%), and 1 case (3%), respectively. Most cases of wire perforation occurred with use of coronary hydrophilic wires (11 cases, 69%) or stiff wires made for chronic total occlusion (2 cases, 13%). Wire or balloon caused only 1 case of type III CP cases (6%), while stent caused 9 cases of type III CP (82%, $p < 0.01$).

A flow chart of treatment for CP is shown in Fig. 1 according to the Ellis classification. In most CP cases (97%), balloon inflations were performed except in 1 case of type I CP. All patients with types I and II CP and 64% of patients with type III CP were successfully managed by prolonged balloon inflation with or without pericardiocentesis without CABG. Incidences of cardiac tamponade and pericardiocentesis were 11% (2 cases out of 19) in types I and II CP and 27% (3 cases out of 11) in type III CP (ns). Seventeen cases out of nineteen (89%) in patients with types I and II CP were managed only by balloon inflation or follow-up, however, 5 cases in type III CP needed pericardiocentesis or CABG ($p < 0.05$). Covered stents were used in 2 cases, however, they could not manage CP because of unsuccessful delivery (1 case) and inadequate coverage (1 case) and these 2 CP cases required CABG. CABG was reserved for those patients who did not achieve hemostasis with conservative methods. Four patients (36%) with type III CP required urgent CABG surgery, while no patient with types I and II CP required it ($p < 0.01$).

Next, we compared the prognoses of CP when they were classified by devices that caused CP as shown in Table 2. While wire, balloon, and atherectomy CP required only 1 case of CABG out of 19 CP cases (5%), stent CP required 3 cases of CABG out of 11 CP cases (27%, ns). Incidences of cardiac tamponade, pericardiocentesis, or CABG were 16% (3 cases out of 19) in wire,

Table 1
Description of the coronary perforation cases.

	All, *N* = 30	Type I, *N* = 17	Type II, *N* = 2	Type III, *N* = 11	*p*-Value
Equipment causing the perforation					
Wire	16 (53%)	14 (82%)	1 (50%)	1 (9%)	0.000
Balloon	2 (7%)	1 (6%)	1 (50%)	0 (0%)	0.131
Stent	11 (37%)	2 (12%)	0 (0%)	9 (82%)	0.000
Atherectomy device	1 (3%)	0 (0%)	0 (0%)	1 (9%)	0.433
Outcome					
Death	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Tamponade	4 (13%)	2 (12%)	0 (0%)	2 (18%)	1.000
Treatment					
Follow-up only	1 (3%)	1 (6%)	0 (0%)	0 (0%)	1.000
Ballooning	29 (97%)	16 (94%)	2 (100%)	11 (100%)	1.000
Ballooning only	22 (73%)	14 (82%)	2 (100%)	6 (55%)	0.248
Pericardiocentesis	5 (17%)	2 (12%)	0 (0%)	3 (27%)	0.554
Covered stent	2 (7%)	0 (0%)	0 (0%)	2 (18%)	0.257
Urgent CABG	4 (13%)	0 (0%)	0 (0%)	4 (36%)	0.038

Data are expressed as number (percentage).
CABG, coronary artery bypass graft.

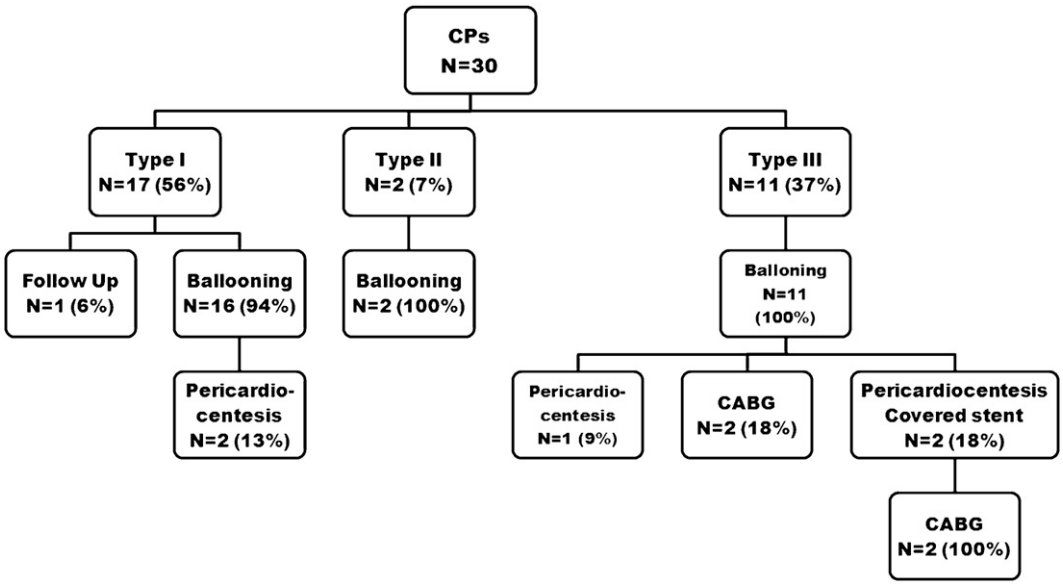

Fig. 1. Flow chart of the treatment for coronary perforation. CPs, coronary perforations; CABG, coronary artery bypass graft.