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Original article

Major adverse cardiac and bleeding events associated with non-cardiac surgery in coronary artery disease patients with or without prior percutaneous coronary intervention

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ABSTRACT

Background: The optimal preoperative therapeutic strategy for patients with coronary artery disease (CAD) is an important concern in the era of drug-eluting stents and antiplatelet therapy. However, there are few studies about the impact of prior percutaneous coronary intervention (PCI) on perioperative major adverse cardiac events (MACEs) and bleeding events associated with oral antiplatelet therapy. The aim of this study was to examine the risks and benefits of performing PCI before non-cardiac surgery (NCS) in patients with CAD.
Methods: We investigated 130 patients who had angiographically significant and stable CAD and underwent NCS after index coronary angiography. We divided the patients into two groups: patients undergoing PCI with coronary stenting (PCI group), and those not undergoing PCI before NCS (no-PCI group), and compared the MACEs and bleeding events within 30 days from NCS between the groups.
Results: There were 53 and 77 patients in the PCI and no-PCI groups, respectively. MACEs were observed in 2 patients (3.8%) in the PCI group and 3 patients (3.9%) in the no-PCI group ($p = 0.97$), whereas bleeding events were observed in 10 (18.9%) and 8 patients (10.4%) in the PCI and no-PCI groups, respectively ($p = 0.17$). There were no significant differences between the two groups in terms of MACEs and bleeding events.
Conclusions: The rate of MACEs following NCS was not significantly different between the PCI and no-PCI groups, while the rate of bleeding events was higher in the PCI group without reaching statistical significance. This study suggests that patients with stable CAD may be able to safely undergo NCS without revascularization even in the presence of significant coronary artery stenosis.

Introduction

The optimal preoperative management for patients with coronary artery disease (CAD) is an important concern. However, there are currently limited data about the efficacy of revascularization before non-cardiac surgery (NCS) in patients with CAD. Previous randomized trials examining the role of revascularization prior to NCS showed that prior revascularization did not improve clinical outcomes in patients with stable CAD [1,2]. However, these studies were conducted in the setting of vascular surgery only, and the mode of revascularization included both percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG). Therefore, the efficacy of PCI prior to various types of NCSs has not been fully examined.

NCS for patients who have undergone successful PCI with stent placement is associated with a number of problems, including bleeding complications resulting from perioperative oral antiplatelet therapy and stent thrombosis (ST), which is a catastrophic occurrence associated with an interruption of oral antiplatelet therapy [3]. Several previous studies have reported on how to manage patients with coronary stents when they present for NCS. The American College of Cardiology (ACC)/American Heart Association (AHA) and European Society of Cardiology (ESC)

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guidelines indicate that elective NCS should be delayed until patients with coronary stents have completed an appropriate course of dual antiplatelet therapy (DAPT) [4–6]. However, to date, there have been few studies comparing the perioperative major adverse cardiac and bleeding events, including ST, between patients with CAD undergoing PCI and those not undergoing PCI prior to NCS.

The purpose of this study was to compare the perioperative major adverse cardiac events (MACEs) between patients with CAD undergoing PCI with coronary stenting and those not undergoing PCI before NCS. Moreover, we also compared the rates of perioperative bleeding events and examined the risks and benefits associated with performing PCI before NCS.

Methods

Study population

We identified 1426 consecutive patients who underwent coronary angiography (CAG) and were diagnosed with angiographically significant CAD between January 1, 2010 and December 31, 2011 at Saitama Medical Center, Jichi Medical University. Patients who did not receive NCS ($n = 1003$) or who received cardiac surgery, including CABG ($n = 176$), were excluded. Furthermore, patients diagnosed with acute coronary syndrome ($n = 33$), ventricular fibrillation ($n = 2$), and pulseless electrical activity ($n = 1$) at the time of CAG were also excluded. In addition, we excluded patients with <90% stenosis, patients without main branch lesions, and patients with only distal lesions ($n = 81$). Finally, 130 patients with ≥90% stenosis in the proximal or mid main branches were included in the analysis. Patients who underwent PCI after CAG and subsequently underwent NCS were defined as the PCI group, whereas patients who did not undergo PCI after CAG were defined as the no-PCI group (Fig. 1). NCS was defined as the first non-cardiac surgical procedure after the CAG, and classified into high-, intermediate-, or low-risk groups in accordance with the ESC guidelines for preoperative cardiac risk assessment and perioperative cardiac management in NCS [6]. Patients who received antiplatelet or anticoagulant therapy within 5 days before NCS were defined as being on preoperative antiplatelet or anticoagulant therapy. Patient data were obtained from their medical records and retrospectively analyzed. The study protocol was approved by the Ethics Committee of Saitama Medical Center, Jichi Medical University.

Coronary revascularization strategy

In our institution, we usually follow the current guidelines when patients are referred for revascularization [7]. PCI is considered for patients with 1- or 2-vessel disease, whereas CABG is considered for patients with 3-vessel or left main disease, and occasionally for patients with 1- or 2-vessel disease, including the proximal left anterior descending artery (LAD). With respect to the stent type, drug-eluting stents (DES) are selected for small vessels (reference diameter ≤2.5 mm) or diffuse lesions (>30 mm), whereas bare metal stents (BMS) are selected for large vessels (reference diameter >4.0 mm) or short lesions (<20 mm).

With regard to the strategy of coronary revascularization for patients scheduled for NCS, there is no definite rule in our institution. However, we usually divide NCS into four subcategories, namely surgeries for early-stage cancer, advanced-stage cancer, stable disease (non-cancer), and unstable disease (non-cancer). In NCS for early-stage cancer, DES can be used for PCI in most cases; however, we tend to prefer BMS implantation. On the other hand, in NCS for stable disease (non-cancer), we generally do not hesitate to use DES. Thus, for these subcategories, we just follow the clinical guidelines in our institution. Conversely, for advanced-stage cancer, we generally prioritize the NCS over coronary revascularization. If the patients have 99% culprit coronary artery stenosis with poor collateral flow, we perform PCI with BMS. In NCS for unstable disease (non-cancer), we prioritize NCS over coronary revascularization as long as the minimum exercise capacity (≥4 metabolic equivalents) is maintained. If the exercise capacity is <4 metabolic equivalents, we prefer to perform coronary revascularization using BMS or CABG before the NCS. In addition, we discuss the indication or strategy

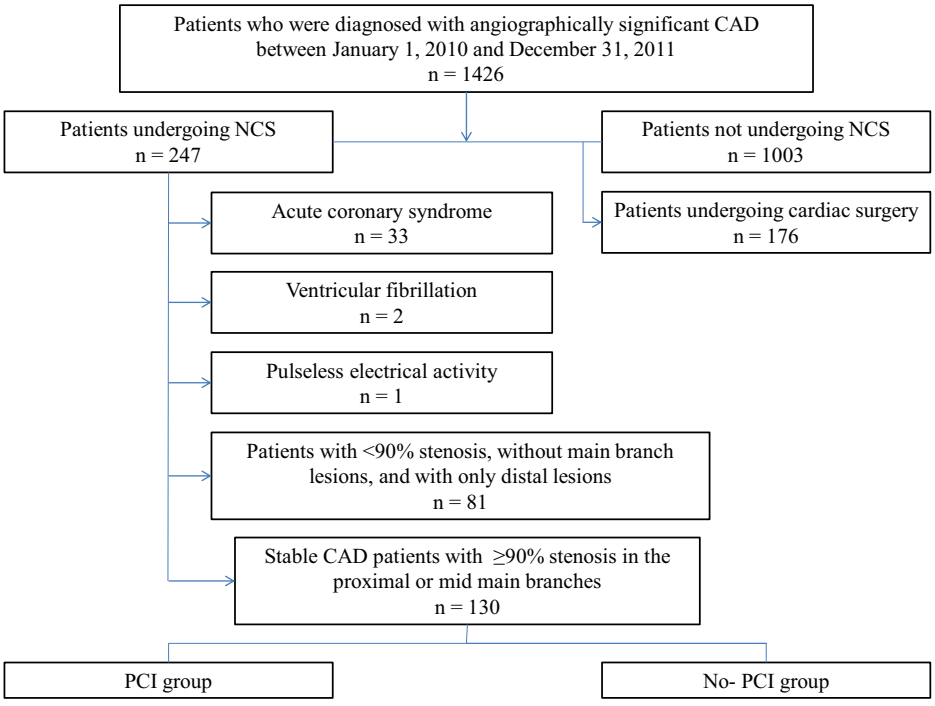

Fig. 1. Flowchart. CAD, coronary artery disease; NCS, non-cardiac surgery; PCI, percutaneous coronary intervention.

for revascularization in our weekly conference for each individual case. Regarding the oral antiplatelet therapy, patients undergoing BMS implantation receive aspirin (100 mg/day) and thienopyridine (ticlopidine 200 mg/day or clopidogrel 75 mg/day) as DAPT for at least 30 days, whereas patients undergoing DES implantation receive DAPT for 6 months or longer in our institution. NCS is usually scheduled 1 month (BMS) or 6–12 months (DES) following stent implantation. Although thienopyridine is often discontinued, aspirin is usually continued during the perioperative period. However, the final decisions regarding the therapy for coronary stenosis (revascularization or medical therapy), the revascularization strategy (CABG or PCI), the stent type (BMS or DES), and the duration of antiplatelet therapy in the perioperative period are made at each attending physician's discretion.

Clinical outcomes

The clinical outcomes were defined as any MACE or bleeding event within 30 days from NCS. Any postoperative myocardial ischemic event, ST, stroke, heart failure, cardiogenic shock, or sudden death was considered as a MACE. ST was defined according to the Academic Research Consortium definition [8]. Bleeding events were defined according to the International Society of Thrombosis and Hemostasis, and categorized as major or minor bleeding [9]. Major bleeding was defined as fatal bleeding, bleeding that was symptomatic and occurred in a critical area or organ, such as intracranial, intraspinal, intraocular, retroperitoneal, pericardial, in a non-operated joint, or intramuscular with compartment syndrome, bleeding causing a fall in hemoglobin level of 20 g/L (1.24 mmol/L) or more, or leading to transfusion of 2 or more units of whole blood or red cells, bleeding warranting treatment cessation, surgical site bleeding that required a second intervention – open, arthroscopic, endovascular – and surgical site bleeding that was unexpected and prolonged and/or sufficiently large to cause hemodynamic instability. In other circumstances, the bleeding was considered minor.

Statistical analysis

Continuous variables are expressed as mean ± SD for normally distributed variables or median (interquartile range) for nonparametric variables. The normality of the data was assessed using the Shapiro–Wilk test. Comparisons for normally distributed variables were performed with independent samples unpaired t-test. Non-parametric variables were analyzed with Mann–Whitney *U*-test. Categorical data were presented as numbers (%) and analyzed using the chi-square test. A value of $p < 0.05$ was considered statistically significant. Data were analyzed using SPSS version 19 (SPSS, Inc., Chicago, IL, USA).

Results

The baseline characteristics of the study patients are shown in Table 1. PCI with coronary stenting before NCS was performed in 41% of all patients (53/130). In the PCI group, DES and BMS implantations were performed in 60% (32/53) and 40% (21/53) of the patients, respectively. In the no-PCI group, revascularization after the NCS was performed in 39% (30/77) of the patients. PCI with DES, PCI with BMS, and CABG were performed in 20, 3, and 7 of these patients, respectively. There were no differences between the PCI and no-PCI groups, except for the preoperative medication such as statins, angiotensin-converting enzyme inhibitors or angiotensin receptor blockers, or antiplatelet agents, and the duration from CAG to NCS. The duration was significantly longer in the PCI group, and patients with DES implantation comprised the vast majority of patients undergoing NCS 12 months or longer after the PCI (DES, 15; BMS, 1). The angiographic findings of the index CAG are shown in Table 2. The

Table 1
Baseline characteristics.

	PCI ($n = 53$)	No-PCI ($n = 77$)	p
Age (years)	73 (66–77)	71 (64–77)	0.31
Men	45 (84.9)	65 (84.4)	0.94
Weight (kg)	62.4 ± 10.5	60.6 ± 9.64	0.30
Height (cm)	162.8 ± 8.21	160.9 ± 7.06	0.16
Hypertension	42 (79.2)	56 (72.7)	0.40
Dyslipidemia	29 (54.7)	42 (54.5)	0.99
Diabetes	22 (41.5)	43 (55.8)	0.11
Active smoking	6 (11.3)	17 (22.1)	0.11
Stroke	7 (13.2)	12 (15.6)	0.71
PVD	12 (22.6)	26 (33.8)	0.17
Previous MI	11 (20.8)	19 (24.7)	0.60
Previous PCI	53 (100)	22 (28.6)	<0.001
Previous CABG	2 (3.8)	9 (11.7)	0.11
CHD	8 (15.1)	16 (20.8)	0.41
Hemodialysis	4 (7.5)	9 (11.7)	0.44
BUN (mg/dl)	17.0 (14.0–24.0)	18.0 (14.0–24.5)	0.61
Creatinine (mg/dl)	0.98 (0.74–1.6)	0.94 (0.78–1.3)	0.93
Hemoglobin (g/dl)	12.4 ± 1.88	12.7 ± 2.08	0.47
Medication			
β-Blockers	31 (58.5)	42 (54.5)	0.66
Statins	46 (86.8)	48 (62.3)	0.002
ACEIs or ARBs	42 (79.2)	44 (57.1)	0.009
Nitrates	9 (17.0)	20 (26.0)	0.23
Anticoagulant agents	7 (13.2)	7 (9.1)	0.46
Antiplatelet agents			
None	6 (11.3)	27 (35.1)	0.002
Aspirin alone	29 (54.7)	40 (51.9)	0.76
Thienopyridine alone	1 (1.9)	1 (1.3)	0.79
DAPT	17 (32.1)	9 (11.7)	0.004
Heparin-alternative therapy	17 (32.1)	15 (19.5)	0.10
Duration from CAG to NCS (months)			<0.001
0–3	20 (37.7)	63 (81.8)	
4–6	5 (9.4)	2 (2.6)	
7–12	12 (22.6)	7 (9.1)	
>12	16 (30.2)	5 (6.5)	

Values are number of patients (%), mean ± SD or median (interquartile range). ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker; BUN, blood urea nitrogen; CABG, coronary artery bypass grafting; CAG, coronary angiography; CHD, congestive heart disease; DAPT, dual antiplatelet therapy; MI, myocardial infarction; NCS, non-cardiac surgery; PCI, percutaneous coronary intervention; PVD, peripheral vascular disease.

Table 2
Angiographic findings.

	PCI ($n = 53$)	No-PCI ($n = 77$)	p
Number of vessels with stenosis			0.52
SVD	22 (41.5)	34 (44.2)	
DVD	17 (32.1)	29 (37.7)	
TVD	14 (26.4)	14 (18.2)	
Location of stenosis			
RCA	33 (62.3)	44 (57.1)	0.56
LAD	40 (75.5)	36 (46.8)	0.001
LCX	27 (50.9)	52 (67.5)	0.057
LMT	1 (1.9)	2 (2.6)	0.79
Graft	1 (1.9)	7 (9.1)	0.093
Quantitative coronary analysis			
Lesion length (mm)	9.55 (7.48–11.8)	9.31 (6.70–13.8)	0.80
Reference diameter (mm)	2.18 (1.87–2.91)	2.17 (1.83–2.71)	0.47
Luminal diameter (mm)	0.72 (0.48–1.05)	0.68 (0.00–0.95)	0.10
% stenosis (%)	66.2 (55.4–76.7)	70.0 (58.4–100)	0.22
ACC/AHA classification			0.26
Type A	19/102 (18.6)	18/140 (12.9)	
Type B1	24/102 (23.5)	32/140 (22.9)	
Type B2	27/102 (26.5)	30/140 (21.4)	
Type C	32/102 (31.4)	60/140 (42.9)	

Values are number of patients (%), number of lesions (%) or median (interquartile range). There were 102 and 140 lesions in the PCI and no-PCI groups, respectively. ACC, American College of Cardiology; AHA, American Heart Association; DVD, double vessel disease; LAD, left anterior descending artery; LCX, left circumflex artery; LMT, left main trunk; PCI, percutaneous coronary intervention; RCA, right coronary artery; SVD, single vessel disease; TVD, triple vessel disease.

Table 3
Comparison of surgical risks between the PCI and no-PCI groups.

	PCI ($n=53$)	No-PCI ($n=77$)	p
Surgical risks			0.64
High-risk	16 (30.2)	29 (37.7)	
Intermediate-risk	16 (30.2)	19 (24.7)	
Low-risk	21 (39.6)	29 (37.7)	

Values are number of patients (%). PCI, percutaneous coronary intervention.

Table 4
Details regarding the NCS.

	PCI ($n=53$)	No-PCI ($n=77$)	p
Types of surgery			0.035
Aortic and major vascular surgery	14 (26.4)	21 (27.3)	
Peripheral vascular surgery	2 (3.8)	8 (10.4)	
Abdominal	4 (7.5)	7 (9.1)	
Carotid	0 (0)	1 (1.3)	
Endovascular aneurysm repair	4 (7.5)	8 (10.4)	
Head and neck surgery	7 (13.2)	1 (1.3)	
Pulmonary	1 (1.9)	1 (1.3)	
Urologic-major	0 (0)	1 (1.3)	
Eye	6 (11.3)	2 (2.6)	
Gynecology	0 (0)	1 (1.3)	
Orthopedic-minor	3 (5.7)	2 (2.6)	
Urologic-minor	5 (9.4)	2 (2.6)	
Others[a]	7 (13.2)	22 (28.6)	
Operative time (min)	166 (55–273)	193 (107–266)	0.27
Unplanned surgery	4 (7.5)	2 (2.6)	0.19

Values are number of patients (%). NCS, non-cardiac surgery; PCI, percutaneous coronary intervention.
[a] Others include cardiovascular implantable electronic device implantation, skin cancer excision, arteriovenous fistula construction for hemodialysis and tracheotomy.

rate of LAD stenosis was significantly higher in the PCI group compared with the no-PCI group. The surgical risks associated with NCS are shown in Table 3. There were no differences relating to surgical risk between the two groups. Comparisons of the types of surgery, operative times, and frequency of unplanned surgery between the groups are shown in Table 4, and details regarding the MACEs and bleeding events within 30 days from NCS are shown in Table 5. There were no significant differences in the frequency of MACEs and bleeding events between the two groups.

A representative case of severe multivessel CAD before NCS is presented in Fig. 2. The CAG showed severe stenosis of the proximal LAD and proximal right coronary artery. This 70-year-old male patient did not undergo PCI and subsequently received

Table 5
Details regarding the MACEs and bleeding events within 30 days from NCS.

	PCI ($n=53$)	No-PCI ($n=77$)	p
MACEs	2 (3.8)	3 (3.9)	0.97
Heart failure	0	1	
Myocardial ischemia	0	1	
Stroke	1	1	
ST, possible	1	0	
Bleeding events	10 (18.9)	8 (10.4)	0.17
Major bleeding	9 (17.0)	6 (7.8)	0.11
Minor bleeding	1 (1.9)	2 (2.6)	0.79
Blood transfusion	5 (9.4)	4 (5.2)	0.35
Bleeding sites			
Surgical site	10	6	
Gastrointestinal	0	2	

Values are number of patients (%). MACE, major adverse cardiac event; NCS, non-cardiac surgery; PCI, percutaneous coronary intervention; ST, stent thrombosis.

carotid endarterectomy within 3 months after the CAG. He was treated with oral aspirin, β-blocker, statin, and angiotensin receptor blocker in the preoperative period, and did not experience any MACE or bleeding event.

Discussion

The findings of this study showed no significant differences in perioperative MACEs between patients with CAD undergoing PCI with coronary stenting and those not undergoing PCI before NCS. The bleeding event rate was higher in the patients undergoing PCI before NCS without reaching statistical significance.

The efficacy of PCI prior to NCS is controversial. To date, there have been two randomized controlled trials investigating the benefits of coronary revascularization before elective major vascular surgery, although the revascularization procedures included both PCI and CABG. The CARP (Coronary Artery Revascularization Prophylaxis) trial, the first randomized trial among patients with stable CAD, showed that coronary artery revascularization did not reduce the number of postoperative myocardial infarctions, deaths, or days in the hospital within 30 days from NCS, although patients with stenosis of the left main coronary artery or severe left ventricular dysfunction were excluded [1]. The DECREASE (Dutch Echocardiographic Cardiac Risk Evaluation Applying Stress Echo)-V study assessed the efficacy of preoperative coronary revascularization in patients with extensive stress-induced ischemia, and showed that preoperative coronary revascularization did not reduce all-cause mortality or myocardial infarction within 30 days from NCS [2]. According to

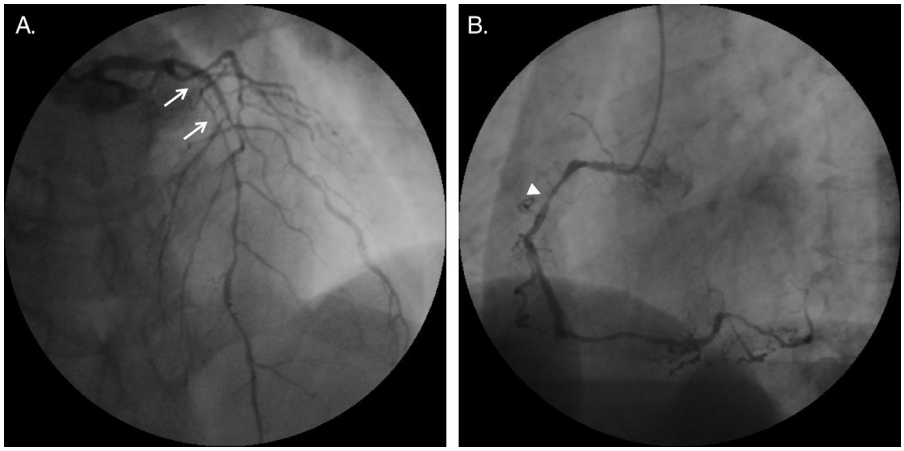

Fig. 2. A representative case of severe multivessel coronary artery disease before non-cardiac surgery. The coronary angiography showed severe stenosis of the proximal left anterior descending artery (arrows) (A) and severe stenosis of the proximal right coronary artery (arrow-head) (B).

these studies, preoperative revascularization appears to be of little or no value in preventing perioperative cardiac events in patients with stable CAD, although the veracity of the results of the DECREASE-V study is controversial. Moreover, the ACC/AHA guidelines also indicate that PCI before NCS is of no value in preventing perioperative cardiac events in patients with stable CAD, and the role of preoperative PCI appears limited to patients with unstable active CAD [5]. The results of the present study also showed no differences in the MACEs between the PCI and no-PCI groups, supporting the recommendation of the ACC/AHA guidelines.

The risk of MACEs, including ST, is notably increased when surgery is performed early after stent implantation, owing to the fact that stents are not endothelialized, and that an inflammatory and prothrombotic state is induced by the surgical stress [4,10–13]. Additionally, premature antiplatelet therapy discontinuation has been identified as a predictor of ST in patients with coronary stents [14]. Concerning bleeding events, DAPT appears to be associated with a higher bleeding risk compared with single antiplatelet therapy (SAPT) in patients undergoing PCI, although few studies have investigated this association [15]. Yamamoto et al. reported that the rate of bleeding events associated with NCS in patients treated with DAPT was significantly higher than that in patients treated with SAPT (9.5% vs. 2.3%, $p = 0.049$) [16], and van Kuijk et al. similarly reported that the risks of severe bleeding in patients with coronary stents receiving DAPT and SAPT at the time of NCS were 21% and 4%, respectively ($p < 0.001$) [17]. Thus, PCI before NCS appears to be associated with a number of problems, and the management of antiplatelet therapy to avoid excessive bleeding while minimizing the risk of ST poses a dilemma. In this study, only one case of possible ST was identified. Although the bleeding event rate tended to be higher in the PCI group than in the no-PCI group, there were no significant differences between the two groups. However, the number of patients included in the present study was relatively low, and a significant difference may be found if we include a larger number of patients.

In this study, the duration from CAG to NCS was significantly longer in the PCI group, and 11 planned NCSs were delayed specifically due to DES implantation. The ACC/AHA and ESC guidelines recommend that elective NCS should be delayed until patients with coronary stents have completed an appropriate course of DAPT to prevent severe bleeding complications and ST [5,6]. Our results suggest that prior PCI delayed NCS according to the recommendation of these guidelines. Considering the complexity of the perioperative management of patients with coronary stents and delayed NCS caused by PCI, we suggest that patients with stable CAD should undergo NCS before PCI.

Study limitations

First, this was a single-center, retrospective study. Therefore, the possibility of selection bias cannot be excluded, and the care of the patients was not controlled by a study protocol. Second, patients who received minor surgery, such as ophthalmic surgery, were included in our analysis. These patients may have a lower risk of MACEs or bleeding events and their inclusion may have affected the results of this study. Third, we did not have access to information regarding the antiplatelet agents other than aspirin and thienopyridine. The other antiplatelet agents might have affected the risks of MACEs or bleeding events. Fourth, we performed only morphological assessment of myocardial ischemia and not functional assessment by stress myocardial scintigraphy or measurement of fractional flow reserve. Fifth, only 39% of the patients in the no-PCI group received revascularization therapy after the NCS. The location and/or morphology of the coronary lesions in the no-PCI group were originally considered inappropriate for PCI, and this is likely the main reason for this low proportion. Lastly, we only estimated the short-term prognosis of the patients, and did not assess whether PCI could predict the long-term clinical outcomes. Further longitudinal and prospective studies are needed to address these issues.

Conclusions

This study showed that the rate of MACEs following NCS was not significantly different between patients undergoing and not undergoing PCI prior to NCS, while the rate of bleeding events was higher in the PCI group without reaching statistical significance. These findings suggest that patients with stable CAD can safely undergo NCS without revascularization, even in the presence of significant coronary artery lesions.

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None.

Conflict of interest

There is no conflict of interest in this study.

References

[1] McFalls EO, Ward HB, Moritz TE, Goldman S, Krupski WC, Littooy F, Pierpont G, Santilli S, Rapp J, Hattler B, Shunk K, Jaenicke C, Thottapurathu L, Ellis N, Reda DJ, et al. Coronary-artery revascularization before elective major vascular surgery. N Engl J Med 2004;351:2795–804.
[2] Poldermans D, Schouten O, Vidakovic R, Bax JJ, Thomson IR, Hoeks SE, Feringa HH, Dunkelgrun M, de Jaegere P, Maat A, van Sambeek MR, Kertai MD, Boersma E, Group DS. A clinical randomized trial to evaluate the safety of a noninvasive approach in high-risk patients undergoing major vascular surgery: the DECREASE-V Pilot Study. J Am Coll Cardiol 2007;49:1763–9.
[3] Kaluza GL, Joseph J, Lee JR, Raizner ME, Raizner AE. Catastrophic outcomes of noncardiac surgery soon after coronary stenting. J Am Coll Cardiol 2000;35:1288–94.
[4] Brilakis ES, Banerjee S, Berger PB. Perioperative management of patients with coronary stents. J Am Coll Cardiol 2007;49:2145–50.
[5] Fleisher LA, Beckman JA, Brown KA, Calkins H, Chaikof E, Fleischmann KE, Freeman WK, Froehlich JB, Kasper EK, Kersten JR, Riegel B, Robb JF. ACC/AHA 2007 Guidelines on Perioperative Cardiovascular Evaluation and Care for Noncardiac Surgery: Executive Summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 2002 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery). Circulation 2007;116:1971–96.
[6] Poldermans D, Bax JJ, Boersma E, De Hert S, Eeckhout E, Fowkes G, Gorenek B, Hennerici MG, Iung B, Kelm M, Kjeldsen KP, Kristensen SD, Lopez-Sendon J, Pelosi P, Philippe F, et al. Guidelines for pre-operative cardiac risk assessment and perioperative cardiac management in non-cardiac surgery. Eur Heart J 2009;30:2769–812.
[7] JCS Joint Working Group. Guidelines for elective percutaneous coronary intervention in patients with stable coronary artery disease (JCS 2011) published in 2012 – digest version. Circ J 2013;77:1590–607.
[8] Cutlip DE, Windecker S, Mehran R, Boam A, Cohen DJ, van Es GA, Steg PG, Morel MA, Mauri L, Vranckx P, McFadden E, Lansky A, Hamon M, Krucoff MW, Serruys PW, et al. Clinical end points in coronary stent trials: a case for standardized definitions. Circulation 2007;115:2344–51.
[9] Schulman S, Angeras U, Bergqvist D, Eriksson B, Lassen MR, Fisher W. Definition of major bleeding in clinical investigations of antihemostatic medicinal products in surgical patients. J Thromb Haemost 2010;8:202–4.
[10] Samama CM, Thiry D, Elalamy I, Diaby M, Guillosson JJ, Kieffer E, Coriat P. Perioperative activation of hemostasis in vascular surgery patients. Anesthesiology 2001;94:74–8.
[11] Vicenzi MN, Meislitzer T, Heitzinger B, Halaj M, Fleisher LA, Metzler H. Coronary artery stenting and non-cardiac surgery – a prospective outcome study. Br J Anaesth 2006;96:686–93.
[12] Hollis RH, Graham LA, Richman JS, Deierhoi RJ, Hawn MT. Adverse cardiac events in patients with coronary stents undergoing noncardiac surgery: a systematic review. Am J Surg 2012;204:494–501.
[13] Devereaux PJ, Goldman L, Cook DJ, Gilbert K, Leslie K, Guyatt GH. Perioperative cardiac events in patients undergoing noncardiac surgery: a review of the magnitude of the problem, the pathophysiology of the events and methods to estimate and communicate risk. CMAJ 2005;173:627–34.
[14] Iakovou I, Schmidt T, Bonizzoni E, Ge L, Sangiorgi GM, Stankovic G, Airoldi F, Chieffo A, Montorfano M, Carlino M, Michev I, Corvaja N, Briguori C, Gerckens U, Grube E, et al. Incidence, predictors, and outcome of thrombosis after successful implantation of drug-eluting stents. JAMA 2005;293:2126–30.

[15] Singla S, Sachdeva R, Uretsky BF. The risk of adverse cardiac and bleeding events following noncardiac surgery relative to antiplatelet therapy in patients with prior percutaneous coronary intervention. J Am Coll Cardiol 2012;60:2005–16.
[16] Yamamoto K, Wada H, Sakakura K, Ikeda N, Yamada Y, Katayama T, Sugawara Y, Mitsuhashi T, Ako J, Momomura SI. Cardiovascular and bleeding risk of non-cardiac surgery in patients on antiplatelet therapy. J Cardiol 2014;64:334–8.
[17] van Kuijk JP, Flu WJ, Schouten O, Hoeks SE, Schenkeveld L, de Jaegere PP, Bax JJ, van Domburg RT, Serruys PW, Poldermans D. Timing of noncardiac surgery after coronary artery stenting with bare metal or drug-eluting stents. Am J Cardiol 2009;104:1229–34.