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CLINICAL RESEARCH

Percutaneous Revascularization for Stable Coronary Artery Disease

Temporal Trends and Impact of Drug-Eluting Stents

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Objectives We sought to determine the characteristics, outcomes, and temporal trends among patients undergoing percutaneous coronary intervention (PCI) for stable coronary artery disease (CAD) from a single-center registry.

Background There is controversy regarding the generalizability of the findings from randomized trials of PCI for stable CAD to daily practice. An important perspective on the significance of the trial results can be achieved by clearly documenting past and present practice of PCI.

Methods This was a retrospective analysis of 8,912 consecutive patients undergoing elective PCI from 1979 through 2006 at a tertiary referral center. Clinical, angiographic, and procedural characteristics as well as in-hospital and long-term outcomes were measured in patients grouped into 4 eras depending on the dominant interventional strategy of that time: percutaneous transluminal coronary angioplasty, early stent, bare-metal stent, and drug-eluting stent.

Results Procedural success rates have improved (81%, 92%, 96%, and 97%, respectively, $p < 0.001$), and in-hospital mortality has decreased significantly (1.0%, 0.8%, 0.1%, and 0.1%, respectively, $p < 0.001$) over time. Kaplan-Meier estimates of mortality at 4 years were 11%, 13%, 10%, and 10%, respectively ($p = 0.4$). The 1-year target lesion revascularization rates in the 4 groups were 29%, 26%, 13%, and 8%, respectively ($p < 0.001$).

Conclusions Procedural success rates in contemporary practice of PCI for stable CAD are excellent with very low in-hospital mortality. Introduction of drug-eluting stents has reduced target lesion revascularization but not mortality among all comers. Outcomes similar to that observed in recent clinical trials are being achieved in routine clinical practice. (J Am Coll Cardiol Intv 2010;3:172–9)

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The practice of percutaneous revascularization for coronary artery disease (CAD) has evolved significantly over time as a consequence of numerous technical and pharmacological advances. These have resulted in an improvement in outcomes and the ability to treat sicker patients as well as those with complex coronary morphology (1). Despite the increasing role of coronary revascularization in patients with acute coronary syndromes, stable CAD remains one of the most common indications for referral to the cardiac catheterization laboratory (2). The relative merits of medical therapy versus percutaneous coronary intervention (PCI) for stable CAD have been investigated in numerous clinical trials (3–6). On the basis of the evidence, the current American College of Cardiology/American Heart Association 2005 guidelines do not recommend PCI as the preferred strategy but rather as a reasonable alternative to medical therapy in selected patients (7).

The publication of the COURAGE (Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation) trial has revitalized the debate regarding the precise role of PCI in stable CAD (8–12). The study indicated that PCI, in combination with optimal medical therapy, does not reduce long-term mortality and nonfatal myocardial infarction (MI) compared with optimal medical therapy alone (13). The applicability and generalizability of these findings from a trial-based, highly selected population to daily clinical practice remains to be determined. This is especially so in light of the findings of the recent Japanese Stable Angina Pectoris study that concluded that PCI was superior to medical therapy alone (14). Before widely applying the findings of the COURAGE trial, it is essential to establish the characteristics of patients that are currently being referred for PCI in clinical practice, which we hypothesized differ significantly from the trial cohort. Thus, the aim of our study was to determine the characteristics, outcomes, and temporal trends among consecutive patients from a single-center registry undergoing percutaneous coronary revascularization for stable CAD.

Methods

Since 1979, patients undergoing percutaneous coronary revascularization at the Mayo Clinic in Rochester, Minnesota have been prospectively followed in our registry, which includes demographic, clinical, angiographic, and procedural data. Immediate post-procedure and in-hospital events are recorded, and each patient is surveyed by telephone with a standardized questionnaire at 6 months, 1 year, and then annually after the procedure by trained data technicians. Ten percent of all records are randomly audited by the supervisor for data integrity. All adverse events are confirmed by reviewing the medical records of the patients followed at our institution and by contacting the patients' physicians and reviewing the hospital records of patients treated elsewhere.

Patients. The inclusion criterion was patients undergoing elective PCI. Patients were excluded if they suffered an MI in the 3 months before the PCI or declined authorization allowing the use of their medical records for research. Of patients with more than 1 qualifying procedure, only the earliest was used. We identified 8,912 outpatients who met these criteria. The patients were grouped into 4 eras according to the dominant interventional strategy at the time: Group 1 (October 1979 to December 1989, n = 1,928) consisted of patients who principally underwent percutaneous transluminal coronary angioplasty (PTCA) alone; Group 2 (January 1990 through December 1996, n = 2,806) consisted of patients from the early stent era in whom stents were predominantly used as a bailout strategy; Group 3 (January 1997 through March 2003, n = 2,715) included patients from the bare-metal stent (BMS) era in whom stenting was the preferred strategy in conjunction with dual oral antiplatelet therapy; and Group 4 (April 2003 through December 2006, n = 1,463) consisted of patients whose PCI reflects contemporary practice and includes treatment with drug-eluting stent (DES). The study was approved by the Institutional Review Board.

Abbreviations and Acronyms

BMS = bare-metal stent(s)
CABG = coronary artery bypass grafting
CAD = coronary artery disease
DES = drug-eluting stent(s)
MACE = major adverse cardiovascular events
MI = myocardial infarction
PCI = percutaneous coronary intervention
PTCA = percutaneous transluminal coronary angioplasty
TLR = target lesion revascularization

Definitions. The number of diseased coronary arteries was defined by the number of major arteries with at least 70% stenosis by visual assessment. Patients with ≥50% stenosis in the left main coronary artery were considered to have 2-vessel disease if there was right dominance and 3-vessel disease if there was left dominance. Major adverse cardiovascular events (MACE) were defined as 1 or more of the following: 1) in-hospital death; 2) Q-wave MI; 3) urgent or emergent coronary artery bypass grafting (CABG) during the index hospital stay; and 4) cerebrovascular accident defined as transient ischemic attack or stroke. Myocardial infarction was diagnosed in the presence of 2 of the following 3 criteria: 1) typical chest pain for at least 20 min; 2) elevation of serum creatine kinase levels (or the MB fraction) >2 times normal; and 3) a new Q-wave on the electrocardiogram. In-hospital deaths included all deaths during the index hospital admission. Severe renal dysfunction was defined as a creatinine of >3.0 mg/dl or a history of dialysis or renal transplant. Procedural success was defined as a reduction of residual luminal diameter stenosis to <50% without in-hospital death, Q-wave MI, or need

for emergency CABG to allow comparison between the PTCA and stent eras. We also defined procedural success for the BMS and DES eras as a reduction of residual luminal diameter stenosis to <20% without in-hospital death, Q-wave MI, or need for emergency CABG. Long-term outcomes included all-cause mortality, combined end point of death or any MI, and target lesion revascularization (TLR). TLR was defined as any attempted percutaneous or surgical revascularization of the target lesion after the initial procedure. Other procedural complications, such as those related to the vascular access site, were not included in the present analysis.

Statistics. Data are presented as the mean ± SD or as a frequency (percentage). Kaplan-Meier methods were used to estimate survival curves. Survival was analyzed in all patients, with follow-up starting on the day of the PCI. Tests for trends across time groups were made with linear contrasts of means in a 1-way analysis of variance model for numerical data (with square root transformation for ordinal discrete variables), the Armitage trend test for categorical data, and linear contrasts of group effects in a Cox proportional hazards model for time-to-event data. To estimate the adjusted effect of treatment era on long-term outcomes, Cox proportional hazards models were employed. Age, sex, and other covariates significantly different between the groups were included as covariates for risk adjustment. These models were run on the subset of PCIs from 1994 onward, because earlier PCIs did not have complete data collection of some important risk factors.

Results

Baseline characteristics. The clinical characteristics of the patients in the 4 groups are summarized in Table 1. There has been a significant and progressive increase in the number of patients with comorbid conditions. The body mass index of the patients has increased steadily, but the frequency of active smokers has diminished. The prevalence of a reduced ejection fraction (≤40%), symptomatic congestive heart failure, and a history of prior PCI has also increased.

Table 1. Baseline Clinical Characteristic

	1979–1989 (n = 1,928)	1990–1996 (n = 2,806)	1997–March 2003 (n = 2,715)	April 2003–2006 (n = 1,463)	p Value*	p Value†
Age, yrs	62.5 ± 10.6	64.8 ± 10.8	66.1 ± 11.0	66.8 ± 11.2	<0.001	0.028
Male	1,383 (72%)	2,097 (75%)	2,000 (74%)	1,038 (71%)	0.59	0.06
Diabetes mellitus	263 (14%)	551 (20%)	659 (24%)	454 (31%)	<0.001	<0.001
Hypertension	881 (46%)	1,470 (53%)	1,773 (67%)	1,114 (79%)	<0.001	<0.001
Hyperlipidemia	698 (42%)	1,277 (52%)	1,904 (76%)	1,180 (85%)	<0.001	<0.001
Smoking status					0.001	0.42
Never	704 (37%)	1,046 (37%)	992 (37%)	547 (39%)		
Former	854 (44%)	1,329 (48%)	1,356 (51%)	688 (49%)		
Current	365 (19%)	418 (15%)	333 (12%)	178 (13%)		
Body mass index, kg/m^2	27.7 ± 4.4	28.4 ± 4.8	29.5 ± 5.5	30.0 ± 5.8	<0.001	0.004
CCS severity					<0.001	<0.001
I	26 (1%)	46 (2%)	60 (2%)	41 (3%)		
II	378 (20%)	764 (27%)	889 (33%)	467 (32%)		
III	680 (35%)	891 (32%)	966 (36%)	315 (22%)		
IV	674 (36%)	860 (31%)	368 (14%)	107 (7%)		
Presentation without chest pain	138 (7%)	244 (9%)	425 (16%)	528 (36%)		
Positive stress test as the predominant indication for PCI	91 (5%)	174 (6%)	409 (15%)	446 (30%)	<0.001	<0.001
Prior PCI	87 (5%)	391 (14%)	697 (26%)	413 (28%)	<0.001	0.07
Prior CABG	307 (16%)	697 (25%)	595 (22%)	333 (23%)	<0.001	0.52
Peripheral vascular disease		115 (11%)	295 (11%)	165 (12%)	0.76	0.60
Cerebrovascular disease		79 (8%)	283 (11%)	161 (11%)	0.007	0.51
Prior myocardial infarction	534 (28%)	920 (33%)	748 (28%)	377 (26%)	0.06	0.21
Congestive heart failure	136 (7%)	265 (10%)	247 (10%)	155 (11%)	<0.001	0.10
Severe chronic renal failure	NA	38 (4%)	78 (3%)	62 (4%)	0.31	0.018
Ejection fraction, %					<0.001	0.75
≤40	84 (4%)	117 (4%)	232 (9%)	151 (10%)		
>40	1,491 (77%)	1,449 (52%)	1,596 (59%)	880 (60%)		
Missing data	353 (18%)	1,240 (44%)	887 (33%)	432 (30%)		

Values are mean ± SD or n (%). *The p value is test for trend across time groups; †p value is test of drug-eluting versus bare-metal stent eras.
CABG = coronary artery bypass grafting; CCS = Canadian Cardiovascular Society Angina Classification; PCI = percutaneous coronary intervention.

Although chest pain has remained the predominant indication for PCI in all time periods, increasingly patients are being referred for PCI on the basis of indications other than angina, which in most cases is a positive stress test. Beta-blockers have become the preferred anti-anginal drug with decreasing use of nitrates and calcium channel blockers over time (Fig. 1). In the most recent cohort, 80% of patients were treated with at least 1 anti-anginal medication at the time of referral for PCI. An increasing proportion of patients are on established aspirin therapy before PCI.

Angiographic and procedural characteristics. Table 2 summarizes the angiographic and procedural characteristics. Approximately one-half of patients had multivessel disease, and 50% of interventions were in the left anterior descending artery. There was no significant change in these characteristics over time. The introduction of DES did not increase in the frequency of multivessel PCI with the vast majority of PCI involving a single vessel. The number of stents used per patient has remained similar in the BMS and DES eras. There has been a trend toward treatment of more complex lesion morphology with increasing prevalence of type C lesions. The frequency of treatment of bifurcation ($p < 0.001$) and calcified lesions ($p \leq 0.001$) has increased in the DES compared with the BMS eras.

Outcomes. Despite the increase in lesion complexity, procedural success has continued to improve and is significantly better ($p < 0.001$) in the BMS and DES cohorts compared with the previous 2 cohorts (Table 3). This has been the result of a marked reduction in abrupt and subacute vessel closure in the stent era, although the rate of branch vessel occlusion remains unchanged.

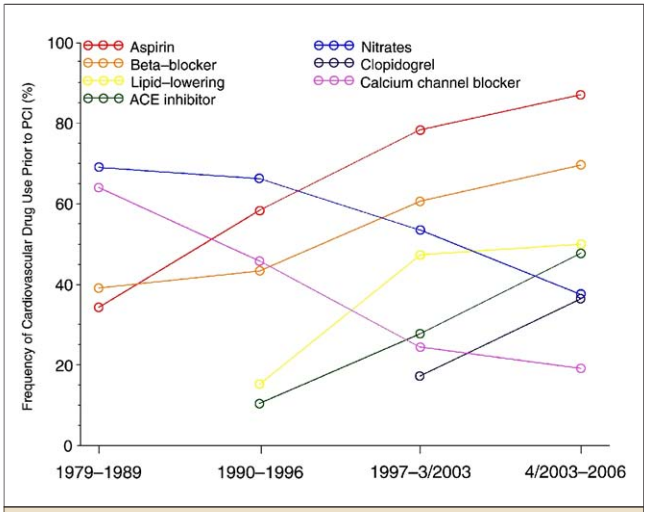

Figure 1. Trends in Medical Therapy

Trends in medication use at the time of admission for percutaneous coronary intervention (PCI). Data regarding lipid-lowering agents and angiotensin-converting enzyme (ACE) inhibitors were not available for the first cohort.

In-hospital mortality decreased over time and is very low (0.1%) in contemporary practice. There has also been a progressive decrease in Q-wave MI, but there has been a minor but statistically significant increase in stroke rates (Table 3). There was also a marked decrease in the rate of in-hospital CABG with the introduction of stents from nearly 10% in the PTCA era to 0.3% in the current era.

Kaplan-Meier estimates for all-cause mortality and the combined end point of death or MI are shown in Figures 2A and 2B, respectively. Median follow-up (interquartile range) was available for 230 (217 to 265) months, 158 (133 to 180) months, 77 (61 to 98) months, and 24 (11 to 36) months, respectively, for the 4 groups. During follow-up, there was no significant difference in the unadjusted mortality rates ($p = 0.41$ for comparison between group). At 4 years, the mortality rates were 11%, 13%, 10%, and 10%, respectively. There was also no difference in the combined end point of death or MI ($p = 0.068$) with event rates at 4 years of 21%, 23%, 19%, and 22%, respectively. The risk-adjusted mortality and the combined end point of death or MI were not significantly different in the stent eras. The TLR rates in the 4 groups were 24%, 21%, 10%, and 4% at 6-months and 29%, 26%, 13%, and 8%, respectively, at 1 year ($p < 0.001$). Target lesion redilation (repeat PCI) rates at 6 months were 10%, 14%, 6%, and 3%, respectively, and at 1-year were 14%, 18%, 9%, and 6%, respectively ($p < 0.001$). Rates of repeat target vessel redilation or CABG at 4 years were 38%, 34%, 21%, and 17%, respectively ($p < 0.001$) (Fig. 2C). There was a reduction in the prevalence of severe angina during follow-up. At 4 years, 58%, 55%, 67%, and 66%, respectively ($p < 0.001$), were free of severe angina.

Discussion

The major findings of the present study among 8,912 patients requiring elective PCI for stable CAD are that the procedures in contemporary practice are generally performed: 1) for symptomatic patients who are receiving anti-anginal therapy; 2) to treat a single vessel in approximately 80% of patients; and 3) with a success rate of 97% and a mortality of <0.1%. Over the past 27 years, PCI is increasingly being performed in patients with greater comorbidities and more complex lesion morphology but with markedly reduced rates of MACE. As seen in clinical trials, the introduction of DES has reduced TLR but not mortality or MI.

Trends over time. In the present study, age as well as the prevalence of diabetes mellitus, hypertension, and hyperlipidemia has increased steadily over each time period. This has been accompanied by greater frequency of adverse lesion characteristics such as type C lesions and calcified lesions. Despite the higher risk setting, there has been over a 10-fold decrease in in-hospital mortality, Q-wave MI, and the need for CABG when comparing the PTCA with the stent eras. This is due, in part, to a reduction in angiographic complica-

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Table 2. Angiographic and Procedural Characteristics

	1979–1989 (n = 1,928)	1990–1996 (n = 2,806)	1997–March 2003 (n = 2,715)	April 2003–2006 (n = 1,463)	p Value*	p Value†
Number of vessels diseased					0.22	<0.001
Single	995 (53%)	1,390 (51%)	1,267 (49%)	720 (56%)		
Double	665 (35%)	949 (35%)	899 (35%)	404 (32%)		
Triple	232 (12%)	385 (14%)	398 (15%)	151 (12%)		
AHA lesion classification					0.015	0.43
B1		406 (20%)	495 (19%)	289 (20%)		
B2		760 (38%)	993 (37%)	473 (33%)		
C		743 (37%)	1,069 (40%)	616 (43%)		
Calcification	247 (13%)	1,029 (39%)	1,000 (40%)	572 (47%)	<0.001	<0.001
Bifurcation lesion		113 (12%)	331 (13%)	235 (17%)	<0.001	<0.001
Number of vessels treated					0.015	0.91
1	1,577 (82%)	2,347 (84%)	2,198 (81%)	1,185 (81%)		
2	326 (17%)	434 (15%)	472 (17%)	256 (18%)		
3	25 (1%)	25 (1%)	45 (2%)	21 (1%)		
Total number of stent placed	0.0 ± 0.0	0.4 ± 0.8	1.4 ± 1.1	1.5 ± 1.0	<0.001	0.81
Bare-metal stent use	2 (0%)	697 (25%)	2,362 (87%)	198 (14%)	<0.001	<0.001
Drug-eluting stent use	0 (0%)	0 (0%)	0 (0%)	1,151 (79%)		
Vessel treated						
Left anterior descending	998 (52%)	1,231 (44%)	1,245 (46%)	732 (50%)	0.39	0.009
Proximal left anterior descending	466 (24%)	485 (17%)	506 (19%)	240 (16%)	<0.001	0.07
Circumflex	521 (27%)	763 (27%)	775 (29%)	399 (27%)	0.50	0.39
Right	650 (34%)	961 (34%)	962 (35%)	489 (33%)	0.74	0.20
Left main	16 (1%)	42 (1%)	47 (2%)	60 (4%)	<0.001	<0.001
Vein graft intervention	121 (6%)	308 (11%)	233 (9%)	83 (6%)	0.22	<0.001

Values are n (%) or mean ± SD. *The p value is test for trend across time groups; †p value is for drug-eluting versus bare-metal stent eras.
AHA = American Heart Association.

tions such as abrupt closure, subacute vessel occlusion, and coronary embolization that are most often due to dissection or thrombus. As a consequence, procedural success rate has increased from 81% to 97%. These findings reflect the numerous technical and pharmacological advances and greater operator expertise over time making it possible to offer percutaneous revascularization to a broader patient population.

While in the PTCA era, procedures were invariably being performed for angina; in the DES era, angina is the predominant symptom in approximately two-thirds of patients. The remainder was primarily referred because of the presence of ischemia on a stress test. We speculate that there might be 2 reasons for the changing practice. First, there is an increasing awareness of the importance of ischemia as a prognostic marker. The efficacy of PCI in relieving ischemia and the potential for improving outcomes in selected patients with stable CAD has recently been demonstrated in a substudy of the COURAGE (Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation) trial and previously in the ACIP (Asymptomatic Cardiac Ischemia Pilot) study (15,16). Second, there is increasing use of noninvasive tests to diagnose CAD, for example, to risk stratify before noncardiac surgery (17). Among those with angina, the majority of patients had moderate symptoms (Canadian Cardiovascular Society class II and III).

Over time, significant changes have occurred in the rates of use of the various classes of anti-anginal therapy (Fig. 1). The use of nitrates and calcium channel blockers has steadily declined, whereas the use of beta-blockers has increased in each subsequent cohort. In addition, the use of antiplatelet therapy, lipid-lowering therapy, and angiotensin-converting enzyme inhibitors has significantly increased over time. These trends in medical therapy for stable CAD reflect the development of evidenced-based practice directed by national guidelines (18), although there is significant potential for improvement, as manifest by the fact that only 68% of patients were treated with statin 1 year after PCI in the DES cohort.

In the present study, the third cohort of 2,715 patients from the BMS era was contemporaneous to the enrollment period of the COURAGE trial, which randomized 1,149 patients to PCI strategy. Compared with the PCI arm of the trial, patients in routine clinical practice have more adverse characteristics (Table 4). Use of medications for secondary prevention was uniformly lower in the present study, underscoring the fact that medical therapy in general clinical practice might be suboptimal when compared with

Table 3. In-Hospital Outcomes

	1979–1989 (n = 1,928)	1990–1996 (n = 2,806)	1997–March 2003 (n = 2,715)	April 2003–2006 (n = 1,463)	p Value*	p Value†
Procedural success	1,566 (81%)	2,573 (91.7%)	2,615 (96.3%)	1,413 (96.6%)	<0.001	0.66
Procedural success (≤20% residual stenosis)	—	—	2,542 (93.6%)	1,397 (95.5%)	—	0.014
Complications						
Branch vessel occlusion	37 (2.0%)	72 (2.6%)	106 (3.9%)	30 (2.1%)	0.08	0.001
Abrupt closure	77 (4.0%)	93 (3.3%)	22 (0.8%)	10 (0.7%)	<0.001	0.65
Subacute vessel closure (<24 h)	133 (7.0%)	122 (4.3%)	30 (1.1%)	13 (0.9%)	<0.001	0.51
Coronary embolization	13 (0.7%)	56 (2.0%)	32 (1.2%)	6 (0.4%)	0.19	0.013
Death	19 (1.0%)	22 (0.8%)	4 (0.1%)	1 (0.1%)	<0.001	0.48
Any myocardial infarction	112 (5.8%)	166 (5.9%)	130 (4.8%)	53 (3.6%)	0.001	0.08
Q-wave myocardial infarction	36 (1.9%)	29 (1.0%)	6 (0.2%)	2 (0.1%)	<0.001	0.55
CABG	184 (9.5%)	70 (2.5%)	20 (0.7%)	5 (0.3%)	<0.001	0.11
Stroke	0 (0.0%)	2 (0.1%)	10 (0.4%)	3 (0.2%)	0.012	0.37
MACE	105 (5.4%)	81 (2.9%)	32 (1.2%)	9 (0.6%)	<0.001	0.08

Values are n (%). *The p value is test for trend across time groups; †p value is test for drug-eluting versus bare-metal stent eras.
CABG = coronary artery bypass grafting; MACE = major adverse cardiac event.

the case management approach of the clinical trial. In contrast, the procedural success rate was higher in the present study. Of note, the composite end point of death or nonfatal MI in the present study at 4 years was identical to that reported in the COURAGE trial at a median follow-up of 4.5 years in the PCI arm of the trial. The mortality was also similar, as was the rate of repeat revascularization. Thus, our findings indicate that "COURAGE- like" results can be achieved in clinical practice, despite the patients being older, with more adverse clinical characteristics, and receiving less intense medical therapy. This might, in part, reflect the higher procedural success rate in our registry (89% vs. 94%). It is probable that outcomes would be even better if optimal medical therapy—as administered in the COURAGE trial—was used, but this would require additional resources to establish an intensive case management approach to secondary prevention that is not generally available.

Comparison of outcomes in the BMS and DES eras. Randomized controlled trials (19,20–23) and observational studies (24) have demonstrated that BMS reduce the rates of TLR compared with PTCA. More recently, DES have been shown to be superior to BMS with regard to reducing restenosis and TLR (25–31). There is a paucity of data on the impact of DES, relative to BMS, on TLR rates and outcomes after PCI for stable CAD in clinical practice. Observational studies to date reporting experience from unrestricted consecutive patients have typically included heterogeneous populations of stable CAD and acute coronary syndrome with follow-up limited to 1 to 2 years (32–36).

The present study provides a unique perspective on PCI for stable CAD from a single registry over 3 decades with long-term follow-up. At 1 year, we observed a 54% relative reduction in clinically driven TLR in the BMS era compared with the early stent era (Fig. 2C). There was a further 40% decrease in 1-year TLR rates with the introduction of DES. Thus, contemporary rates of TLR at 1 year are 76% less compared with the PTCA era. These findings confirm that the benefits seen in the pivotal trials are being translated to clinical practice, despite the frequent "off-label use" of the stents (37,38). Moreover, we demonstrate that the benefit with regard to TLR is sustained over the entire duration of follow-up, which in the case of BMS was 10 years. In contrast, there has been no change in the unadjusted rates of mortality or the combined end point of death or MI in the DES era, compared with the BMS era (Figs. 2A and 2B). These data must be interpreted with the knowledge that there has been a marked change in patient characteristics and also pharmacological therapy for secondary prevention over the different time periods, making direct comparison difficult and unreliable. To account for this fact, risk-adjusted models for outcomes were analyzed but did not demonstrate an independent impact of treatment era on mortality or the combined end point of death or MI. It is reassuring that over 4 years of follow-up DES use was not associated with worse outcomes compared with BMS, given the concerns over stent thrombosis with the newer stents (30). Our finding that the introduction of BMS and DES have not improved survival in stable CAD is entirely consistent with the findings in the randomized trials (13,19,20,39–41).

Study limitations. Although the data were collected prospectively, this is a retrospective single-center analysis and is subject to the limitations of such analyses. Our registry did not record the occurrence of stent thrombosis during the study period, and hence we cannot explore the impact of DES on this phenomenon. The study is limited to patients treated with PCI, and we cannot comment on the trends in outcomes for patients who are managed with medical therapy or surgical revascularization.

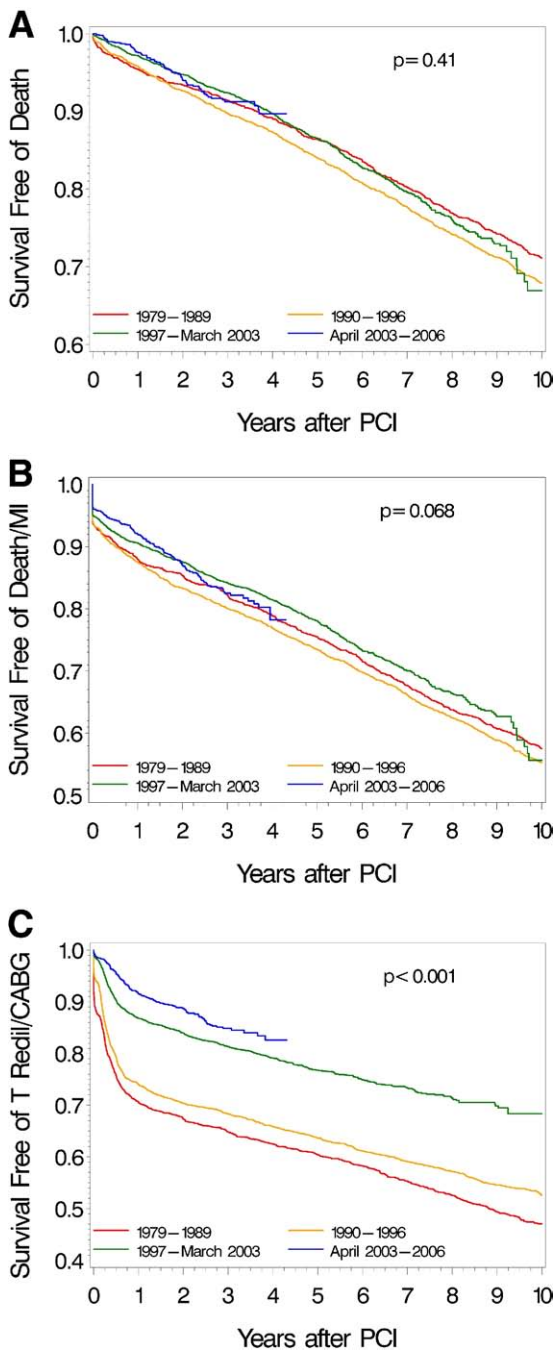

Figure 2. Long-Term Mortality and Composite End Points of Death or MI and Repeat Target Lesion Redilation or CABG

Kaplan-Meier curves showing survival free of **(A)** death, **(B)** death/myocardial infarction (MI), and **(C)** target lesion redilation (T Redil)/coronary artery bypass grafting (CABG). PCI = percutaneous coronary intervention.

Conclusions

Elective PCI for stable CAD is being performed, as with other patient subsets, in increasingly older patients with more complex lesion morphology. The routine use of stents has greatly reduced complication and improved procedural success rates. It is encouraging to note that outcomes in the BMS era were similar to those observed in the randomized COURAGE trial, even though our patients seemed to have more adverse characteristics. The introduction of DES has been associated with lower TLR without altering mortality or MI. Continued surveillance is required to assess the long-term impact of DES on mortality in large cohorts of patients.

Table 4. Comparison of Patient Characteristics and Outcomes in the COURAGE Trial With the Mayo Clinic Registry BMS Cohort

Variable	COURAGE	Mayo Registry
Age, yrs	61.5 ± 10.1	66.1 ± 11.0
Female	15%	26%
CCS class III angina	23%	36%
Prior PCI	23%	26%
Prior CABG	11%	22%
Symptomatic CHF	5%	10%
Medications at 1 yr		
Aspirin	95%	91%
Lipid-lowering therapy	93%	77%
ACE inhibitors	64%	38%
Procedural success	89%	94%
Outcomes at 4 yrs		
Mortality	8%	10%
Death/MI	19%	19%
Repeat revascularization	21%	21%

Values are mean ± SD or %.

ACE = angiotensin-converting enzyme; BMS = bare-metal stent(s); CABG = coronary artery bypass grafting; CCS = Canadian Cardiovascular Society; CHF = congestive heart failure; COURAGE = Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation trial; MI = myocardial infarction; PCI = percutaneous coronary intervention.

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