

EFFECT OF SMOKING STATUS ON THE LONG-TERM OUTCOME AFTER SUCCESSFUL PERCUTANEOUS CORONARY REVASCULARIZATION

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ABSTRACT

Background Cigarette smoking is known to be deleterious to patients with coronary artery disease, but the effect of smoking on the clinical outcome of percutaneous coronary revascularization is unknown.

Methods Patients who had undergone successful percutaneous coronary revascularization at the Mayo Clinic between 1979 and 1995 were divided into nonsmokers (n=2009), former smokers (those who had stopped smoking before the procedure, n=2259), quitters (those who stopped smoking after the procedure, n=435), and persistent smokers (those who smoked before and after the procedure, n=734).

Results The maximal follow-up was 16 years (mean \pm SD), 4.5 ± 3.4). The nonsmokers and former smokers had similar base-line characteristics and outcomes. The quitters and persistent smokers were younger than the nonsmokers and former smokers and had more favorable clinical and angiographic characteristics. In analyses adjusted for confounding base-line characteristics, the persistent smokers had a greater relative risk of death (1.76 [95 percent confidence interval, 1.37 to 2.26]) and of Q-wave infarction (2.08 [95 percent confidence interval, 1.16 to 3.72]) than the nonsmokers. The quitters and persistent smokers were less likely than the nonsmokers to undergo additional percutaneous coronary procedures (relative risk, 0.80 [95 percent confidence interval, 0.64 to 0.98] and 0.67 [95 percent confidence interval, 0.56 to 0.81], respectively) or coronary bypass surgery (relative risk, 0.72 [95 percent confidence interval, 0.54 to 0.95] and 0.68 [95 percent confidence interval, 0.54 to 0.86], respectively). The persistent smokers were also at greater risk for death than the quitters (relative risk, 1.44 [95 percent confidence interval, 1.02 to 2.11]).

Conclusions Patients who continued to smoke after successful percutaneous coronary revascularization were at greater risk for Q-wave infarction and death than nonsmokers. The cessation of smoking either before or after percutaneous revascularization was beneficial. Patients undergoing percutaneous revascularization should be encouraged to stop smoking. (N Engl J Med 1997;336:755-61.)

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CIGARETTE smoking is a well-established risk factor for the development and progression of coronary heart disease¹⁻⁴ and is strongly related to morbidity and mortality from cardiovascular causes.^{5,6} Conversely, the excess risk of cardiovascular events gradually declines after the cessation of smoking.^{7,8} Previous studies have

shown that the cessation of smoking after coronary bypass surgery may have an important beneficial effect on clinical events during long-term follow-up.^{9,10} However, the effect of smoking status before and after percutaneous coronary revascularization on the long-term outcome is not well established.

The aims of this study were to examine the effect of smoking status on the long-term outcome after successful percutaneous coronary revascularization and to determine whether the cessation of smoking before or after the index intervention affected event-free survival. We performed a retrospective analysis of all patients who had undergone percutaneous coronary revascularization at the Mayo Clinic during a 16-year period.

METHODS

During the period from the introduction of coronary balloon angioplasty at the Mayo Clinic, in September 1979, through December 31, 1995, a total of 6600 patients underwent percutaneous coronary revascularization and did not have acute myocardial infarction within 24 hours before the intervention. Complete base-line data were available for 6424 of these patients (97 percent). The 5450 patients (85 percent) in whom the index procedure was clinically successful (as defined below) were the focus of this study.

The Mayo Clinic Registry

Since 1979, all patients undergoing percutaneous revascularization at the Mayo Clinic have been followed according to a protocol approved by the clinic's institutional review board. This registry includes base-line demographic, clinical, and angiographic data. All patients are interviewed in person or by telephone 6 and 12 months after the initial procedure and yearly thereafter. Data from visits and hospitalizations at the Mayo Clinic and other institutions are obtained for review. Patients give written informed authorization for the release of all such information.

Clinical Data

The choice of percutaneous coronary revascularization rather than medical or surgical therapy was made by the attending cardiologist. Initially, only balloon angioplasty was performed, according to conventional techniques.¹¹ Later in the study period, other procedures, such as atherectomy, laser angioplasty, and coronary stenting, were also employed, although balloon angioplasty remained the most common procedure. In cases of multivessel disease, the culprit lesion was generally treated first. Identification of the culprit lesion was based on the findings on electrocardiography, regional left ventricular functional studies, thallium scintigraphy, and coronary angiography.

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Follow-up angiography was usually performed only if the attending physician was concerned about recurrent symptoms suggestive of myocardial ischemia. The need for additional coronary revascularization of the target lesion or other segments was also determined by the attending physician. Although all additional percutaneous coronary interventions were documented, data on the segment treated were available only for procedures performed at the Mayo Clinic. The left ventricular ejection fraction was determined by ventriculography at the time of diagnostic angiography in most patients, and during follow-up, as indicated clinically, by echocardiography, radionuclide studies, or left ventricular angiography.

The severity of coronary artery disease was assessed visually by at least two observers using orthogonal views. Single-vessel coronary artery disease was defined as stenosis of at least 70 percent of the diameter of only one major epicardial artery. Two- or three-vessel disease was diagnosed if there were one or two additional major epicardial arteries with at least 70 percent stenosis, respectively. Among patients with 50 percent or more stenosis of the left main coronary artery, those with a right dominant artery were considered to have two-vessel disease and those with a left dominant artery were considered to have three-vessel disease.

Q-wave myocardial infarction was defined as the presence of new Q waves on the electrocardiogram,¹² with serum creatine kinase concentrations that were at least three times higher than normal or positive tests for MB isoenzymes, an episode of prolonged angina, or new regional wall-motion abnormalities.

Angina was classified according to the classification system of the Canadian Cardiovascular Society.¹³ Severe angina was defined as class III or IV.

Complete revascularization was defined as successful dilation of all stenoses of 70 percent or more. Incomplete revascularization was defined as successful dilation of one or more stenoses but with one or more remaining arteries with at least 70 percent stenosis.

The angiographic success of revascularization was defined as a reduction of at least 20 percentage points in the stenosis of at least one lesion, resulting in a residual stenosis of less than 50 percent of the luminal diameter. Clinical success was defined as angiographic success without the in-hospital complications of death, Q-wave myocardial infarction, or referral for coronary-artery bypass grafting.

Death from cardiac causes was defined as death due to myocardial infarction, an arrhythmic event, heart failure, or complications of cardiac surgery or transplantation.

Smoking Status

Patients were queried about their smoking habits at base line and during follow-up; a patient reporting any cigarette smoking in the prior six months was considered a smoker. The study population was divided into four groups on the basis of smoking status at base line: nonsmokers, defined as patients who had never smoked cigarettes regularly; former smokers, those who had quit smoking at least six months before the index procedure; quitters, those who permanently quit smoking immediately after the index procedure; and persistent smokers, those who smoked before and after the index procedure. The small number of patients (13) who first started to smoke during the follow-up period were excluded from our analysis.

End Points

The end points of the study were death from any cause, Q-wave acute myocardial infarction or severe angina, and the need for coronary-artery bypass grafting or repeated percutaneous revascularization.

Statistical Analysis

Continuous data are expressed as means \pm SD, and differences among the four groups of patients were tested for significance with one-way analyses of variance. Discrete data are presented as percentages, and comparisons among the groups were made with

Pearson's chi-square test. For each of the follow-up events, Cox proportional-hazards analysis was used to estimate the relative risk for former smokers, quitters, and persistent smokers as compared with nonsmokers. The results are presented with 95 percent confidence intervals. The likelihood-ratio test was used to determine significant differences among the groups. A proportional-hazards model was developed for each of the end points by using backward selection. Age, sex, severe angina, prior coronary bypass surgery, prior myocardial infarction, congestive heart failure, history of diabetes mellitus, history of hypertension, complete revascularization, multivessel coronary artery disease, the number of vessels dilated, family history of coronary artery disease, and unstable angina were the covariates used in the modeling process. Once a model was selected, the dichotomous variables for former smokers, quitters, and persistent smokers were added to complete the multivariate model. A group analysis was conducted with only patients who were smokers at the time of the initial intervention (i.e., quitters and persistent smokers). The relative risk of continued smoking, as compared with quitting, was estimated with the use of the same procedure. The adjusted survival curves were generated from the multivariate model by allowing the variable associated with the smoking status to change. The other risk factors in the model were held constant by setting each factor equal to its mean value.

RESULTS

The base-line clinical and angiographic characteristics of the four groups of patients are shown in Table 1. Several significant differences were identified. The nonsmokers were older, had had angina for longer periods, and presented with severe angina more frequently than the persistent smokers or quitters, and a larger proportion of nonsmokers were women. In addition, major coexisting conditions such as hypertension and diabetes mellitus were as much as two times as prevalent among the nonsmokers as among the quitters and persistent smokers. The nonsmokers had more extensive coronary artery disease, higher rates of prior coronary bypass surgery, and lower rates of complete revascularization during the index intervention.

The clinical and angiographic characteristics of the former smokers resembled those of the nonsmokers. They were older, had more coexisting conditions, had more extensive coronary artery disease, and had undergone more surgical revascularization procedures than the quitters and persistent smokers. However, the latter patients had higher rates of prior myocardial infarction.

The rate of clinical success of the index procedure was similar in all four groups (approximately 85 percent, data not shown). Among the patients in whom the procedure was successful, 99 percent, 98 percent, 100 percent, and 98 percent of the nonsmokers, former smokers, quitters, and persistent smokers, respectively, reported a substantial improvement in their symptoms at discharge. Patients were followed for up to 16 years after the index procedure (mean, 4.5 ± 3.4 years), with a shorter mean duration of follow-up for the nonsmokers and former smokers (4.4 ± 3.2 and 4.2 ± 3.2 years, respectively) than for the quitters and persistent smokers (5.1 ± 3.7 years and 5.3 ± 3.7 years, respectively).

TABLE 1. BASE-LINE CLINICAL AND ANGIOGRAPHIC CHARACTERISTICS OF 5437 PATIENTS UNDERGOING SUCCESSFUL PERCUTANEOUS CORONARY REVASCULARIZATION, ACCORDING TO SMOKING STATUS.*

CHARACTERISTIC	NONSMOKERS (N=2009)	FORMER SMOKERS (N=2259)	QUITTERS (N=435)	PERSISTENT SMOKERS (N=734)
Age — yr	67±11	65±10	56±10	55±11
Male sex — no. of patients (%)	1166 (58)	1871 (83)	329 (76)	557 (76)
Angina — no. of patients (%)	1846 (92)	2078 (92)	414 (95)	681 (93)
Duration of angina — mo	41±66	51±72	21±46	29±55
Duration of angina at present level (mo)	4±15	4±17	2±8	3±7
Class III or IV angina — no. of patients (%)	1367 (68)	1465 (65)	297 (68)	483 (66)
Unstable angina — no. of patients (%)	1461 (73)	1624 (72)	343 (79)	534 (73)
Heart failure — no. of patients (%)				
Ever	242 (12)	231 (10)	23 (5)	52 (7)
Current	145 (7)	130 (6)	17 (4)	31 (4)
Ejection fraction — %†	64±13	64±13	62±13	63±12
Diabetes mellitus — no. of patients (%)	424 (21)	402 (18)	36 (8)	77 (10)
Hypertension — no. of patients (%)	1082 (54)	1095 (48)	165 (38)	286 (39)
Hypercholesterolemia — no. of patients (%)	810 (40)	877 (39)	142 (33)	282 (38)
Family history of CAD — no. of patients (%)	380 (19)	456 (20)	101 (23)	224 (31)
Pack-years of smoking	—	37±27	45±25	49±27
Prior myocardial infarction — no. of patients (%)	836 (42)	1029 (46)	234 (54)	378 (51)
Prior CABG — no. of patients (%)	351 (17)	514 (23)	45 (10)	89 (12)
Extent of CAD — no. of patients (%)				
1 vessel	1008 (50)	1143 (51)	246 (57)	406 (55)
2 vessels	725 (36)	815 (36)	147 (34)	261 (36)
3 vessels	276 (14)	301 (13)	42 (10)	67 (9)
No. of vessels dilated	1.2±0.4	1.2±0.4	1.2±0.4	1.1±0.4
Index procedure — no. of patients (%)				
PTCA alone	1600 (80)	1721 (76)	347 (80)	598 (81)
Atherectomy with or without PTCA	155 (8)	166 (7)	27 (6)	52 (7)
Laser angioplasty with or without PTCA	60 (3)	85 (4)	9 (2)	17 (2)
Stenting with or without PTCA	158 (8)	242 (11)	38 (9)	56 (8)
Other combination	36 (2)	45 (2)	5 (1)	11 (1)
Stenosis — % of luminal diameter				
Before intervention	87±10	87±15	88±11	87±11
After intervention	27±16	27±17	28±17	28±15
Complete revascularization — no. of patients (%)	1154 (57)	1299 (58)	280 (64)	441 (60)

*Former smokers were defined as patients who had stopped smoking at least six months before undergoing the index procedure, quitters as those who quit smoking immediately after the index procedure, and persistent smokers as those who smoked before and after the procedure. Plus-minus values are means ±SD. CAD denotes coronary artery disease, CABG coronary-artery bypass grafting, and PTCA percutaneous transluminal coronary angioplasty. Percentages may not sum to 100 because of rounding.

†Data on the ejection fraction were available for 1252 nonsmokers, 1402 former smokers, 315 quitters, and 508 persistent smokers.

In the univariable analysis (Table 2), the quitters and persistent smokers had lower risks of death from all causes and severe angina than the nonsmokers. In contrast, the risk of Q-wave myocardial infarction was lower in the nonsmokers than in the persistent smokers. During the follow-up period, percutaneous or surgical revascularization was performed more frequently in the nonsmokers and former smokers than in the other two groups. Six months after the index intervention, 11.8 percent of the nonsmokers, 12.3 percent of the former smokers, 13.4 percent of the quitters, and 8.0 percent of the persistent smokers had undergone additional percutaneous coro-

nary revascularization (P<0.05 for the difference between the persistent smokers and the other three groups). Among the patients who underwent repeated percutaneous coronary revascularization at the Mayo Clinic, revascularization of the same target segment as in the initial procedure was documented in 777 patients. The quitters and persistent smokers had a lower risk of repeated percutaneous revascularization of the same segment than the nonsmokers (relative risk, 0.93 [95 percent confidence interval, 0.71 to 1.22] and 0.65 [95 percent confidence interval, 0.51 to 0.94], respectively).

When the data were adjusted for the base-line var-

TABLE 2. UNADJUSTED AND ADJUSTED RELATIVE RISKS OF MAJOR ADVERSE EVENTS OR REPEATED REVASCULARIZATION.*

EVENT	NONSMOKERS (N=2009)	FORMER SMOKERS (N=2259)	QUITTERS (N=435)	PERSISTENT SMOKERS (N=734)
Death from all causes				
No. of events	296	343	41	97
Unadjusted relative risk	1.0	1.08 (0.92–1.26)	0.56 (0.40–0.77)	0.74 (0.59–0.94)
Adjusted relative risk	1.0	1.34 (1.14–1.57)	1.21 (0.87–1.70)	1.76 (1.37–2.26)
Q-wave myocardial infarction				
No. of events	25	38	9	22
Unadjusted relative risk	1.0	1.41 (0.85–2.33)	1.49 (0.70–3.20)	2.08 (1.17–3.69)
Adjusted relative risk	1.0	1.28 (0.77–2.16)	1.44 (0.64–3.11)	2.08 (1.16–3.72)
Severe angina				
No. of events	846	886	159	307
Unadjusted relative risk	1.0	0.94 (0.86–1.04)	0.80 (0.68–0.95)	0.89 (0.78–1.02)
Adjusted relative risk	1.0	0.99 (0.90–1.09)	0.91 (0.76–1.08)	0.98 (0.86–1.12)
Repeated percutaneous procedure				
No. of events	544	572	108	167
Unadjusted relative risk	1.0	0.96 (0.85–1.08)	0.86 (0.70–1.06)	0.73 (0.61–0.87)
Adjusted relative risk	1.0	0.93 (0.83–1.05)	0.80 (0.64–0.98)	0.67 (0.56–0.81)
Coronary bypass surgery				
No. of events	324	353	62	109
Unadjusted relative risk	1.0	1.0 (0.86–1.17)	0.80 (0.61–1.05)	0.80 (0.64–0.99)
Adjusted relative risk	1.0	0.95 (0.81–1.11)	0.72 (0.54–0.95)	0.68 (0.54–0.86)

*Nonsmokers served as the reference group for the univariable and multivariable analyses. Numbers in parentheses are 95 percent confidence intervals. See the Methods section for the covariates used in the multivariable analysis.

ables significantly associated with each end point (Table 2), the persistent smokers had a greater risk of death from all causes (relative risk, 1.76) and Q-wave myocardial infarction (relative risk, 2.08) than the nonsmokers. Both quitters and persistent smokers were less likely to undergo additional percutaneous procedures (relative risk, 0.80 and 0.67, respectively) or surgical procedures (relative risk, 0.72 and 0.68, respectively) than the nonsmokers. The risk of severe angina was similar in all four groups. The relative risk of death from cardiac causes for former smokers, quitters, and persistent smokers as compared with nonsmokers was 1.28 (95 percent confidence interval, 1.04 to 1.58), 1.02 (95 percent confidence interval, 0.63 to 1.64), and 1.44 (95 percent confidence interval, 1.04 to 2.04), respectively.

We calculated the risk of death from all causes among the persistent smokers as compared with the risk among the quitters, after adjusting for significant differences in base-line variables, in order to assess the effect of smoking cessation on long-term mortality. The persistent smokers had a significantly greater risk of overall mortality (relative risk, 1.44; 95 percent confidence interval, 1.02 to 2.11) (Fig. 1). After adjustment of the data for differences in base-line variables, the estimated survival curves for the patients who quit smoking and those who continued to smoke diverged soon after the index percutaneous intervention, and the difference between the two curves increased throughout the follow-up period. The estimated benefit in survival associated with the cessation of smoking increased from 1 per-

centage point at 1 year (99 percent vs. 98 percent) to 3 percentage points at 5 years (95 percent vs. 92 percent) and to 6 percentage points at 10 years (86 percent vs. 80 percent). As compared with the quitters, the persistent smokers were also at greater risk for death from cardiac causes during the follow-up period (relative risk, 1.49; 95 percent confidence interval, 0.89 to 2.51).

DISCUSSION

A substantial proportion of patients undergoing percutaneous coronary interventions smoke cigarettes. Indeed, in our study, 1169 patients (22 percent) were smokers at the time of the index percutaneous intervention, of whom 734 (63 percent) continued to smoke thereafter. Although the cessation of cigarette smoking is strongly recommended after percutaneous revascularization,¹⁴ there are few long-term data on mortality, morbidity, and the need for repeated revascularization in relation to cigarette smoking or its cessation in patients undergoing percutaneous coronary revascularization.

In our study, after adjustment for base-line clinical and angiographic characteristics, the persistent smokers had a greater risk of death or Q-wave myocardial infarction than the nonsmokers during follow-up. The long-term risk of death from any cause was 44 percent greater in the patients who continued smoking than in those who quit. With adjustment for differences in base-line variables, the estimated survival curves for the two groups diverged early after the index percutaneous intervention and continued to di-

verge throughout the follow-up period. The beneficial effect of smoking cessation on mortality may be due primarily to the reduction in deaths from cardiac causes, since the relative risk of death from cardiac causes was 49 percent higher for the persistent smokers than for the quitters.

The cessation of smoking before percutaneous coronary revascularization was also beneficial. At the time of the procedure, the smokers (both those who quit smoking after the procedure and those who continued to smoke) were approximately 10 years younger than the former smokers and the nonsmokers. The earlier onset of coronary atherosclerosis in the smokers may be attributed to their smoking, since they had fewer coexisting conditions predisposing them to coronary atherosclerosis, such as diabetes mellitus and hypertension, than the former smokers and the nonsmokers. The clinical and angiographic characteristics of the former smokers were similar to those of the nonsmokers, and the two groups accordingly had similar outcomes.

Smoker's Paradox

There is conclusive evidence of the causal role of cigarette smoking in heart disease. Smoking more than doubles the incidence of coronary artery disease and increases mortality from coronary disease by 70 percent.¹⁵ It is therefore surprising that in our study, the patients who were smokers at the time of the index percutaneous intervention had fewer adverse events in the univariable analysis than the nonsmokers and former smokers. Barbash et al.¹⁶⁻¹⁸ and others¹⁹ have reported similar findings in patients receiving thrombolytic therapy for acute myocardial infarction — namely, better outcomes among the smokers. This phenomenon has been coined the “smoker's paradox.”¹⁶ The better prognosis for the smokers in these studies was explained, in part, by their younger age and more favorable clinical and angiographic profile. In our study, the risk of death or Q-wave myocardial infarction was as much as two times higher in the smokers, after the outcome data had been adjusted for these differences in base-line characteristics. Thus, this apparent paradox should not be interpreted as a relative benefit of cigarette smoking. On the contrary, because the relatively better clinical and angiographic profile of the smokers is offset by their use of tobacco, these findings underscore the detrimental effect of cigarette smoking.

Repeated Revascularization

During the follow-up period, repeated revascularization procedures, either percutaneous or surgical, were performed more frequently in the patients who were nonsmokers at the time of the index procedure than in those who were smokers. A similar trend has been reported in the Coronary Artery Surgery Study.²⁰ There are several possible explanations



Figure 1. Estimated Survival Curves for Smokers Undergoing Percutaneous Coronary Revascularization, According to Subsequent Smoking Status.

Persistent smokers were defined as patients who smoked before and after the index procedure, and quitters as those who quit smoking immediately after the procedure.

for these results. First, differences in the rates of restenosis between smokers and nonsmokers would affect the rate of additional revascularization procedures, at least within six to nine months after the index procedure.²¹ Cigarette smoking has been reported either to have no effect^{21,22} or to increase the rate of restenosis^{23,24} after coronary angioplasty. However, among the relatively few patients in our study for whom data were available on repeated revascularization of the target lesion, the quitters and persistent smokers were at lower risk for repeated revascularization than the nonsmokers. Our study was not designed to assess the rate of restenosis, because follow-up coronary angiography was not routinely performed, and data on the revascularization of target lesions were restricted to patients who underwent repeated revascularization at the Mayo Clinic. Thus, our limited data offer little insight into the effect of cigarette smoking on the rate of restenosis after percutaneous coronary revascularization.

Second, the modification of risk factors — or the lack of modification — may influence decision making about subsequent revascularization procedures. Physicians may be reluctant to perform invasive revascularization procedures in patients who continue to smoke. A policy of not performing revascularization in persistent smokers has been advocated by some clinicians^{25,26} but is not followed in our institution.

Third, patients in whom revascularization is incomplete during percutaneous coronary interventions often undergo additional revascularization.²⁷ In our study, complete revascularization was achieved in a slightly smaller proportion of nonsmokers (57 percent) than smokers (60 to 64 percent). This small difference does not explain the 20 to 30 percent difference in additional percutaneous and surgical re-

vascularization procedures between smokers and nonsmokers during follow-up.

Fourth, the smokers had higher risks of myocardial infarction and death than the nonsmokers in the multivariable analysis. The morbidity and mortality among the smokers may have precluded further interventions. But this explanation is unlikely, given that the curves for repeated revascularization began to diverge much earlier than the observed differences in morbidity and mortality occurred.

Finally, nonsmokers frequently have coexisting conditions, such as diabetes mellitus and hypertension, which may accelerate the progression of coronary artery disease and necessitate additional revascularization procedures. When the analysis was adjusted for these coexisting conditions, however, the smokers still underwent fewer revascularization procedures during follow-up. Thus, the smaller number of referrals for repeated revascularization procedures in the smokers remains an enigma.

Activity of Coronary Artery Disease

Our results are in accordance with previous studies that have shown that cigarette smoking may accelerate atherogenesis.¹⁻⁴ The smokers began having angina approximately 10 years earlier than the nonsmokers or former smokers. Furthermore, our data suggest that smokers may be more prone to the development of unstable plaques and hence have more episodes of acute myocardial ischemia. Indeed, the incidence of myocardial infarction before the index percutaneous procedure was approximately 25 percent higher in the smokers, even though they had less extensive coronary artery disease. Moreover, the risk of Q-wave acute myocardial infarction during the follow-up period was as much as two times as high in the smokers as in the nonsmokers. These findings are consistent with the results of a study by Barry et al.,²⁸ who reported substantially more daily episodes of ischemia in smokers with stable angina, as discerned by ambulatory electrocardiography, than in nonsmokers. This increased risk of active ischemia may be related to the procoagulant^{19,29} and coronary vasoconstrictive effects³⁰ of cigarette smoking.

Conclusions

Considerable resources are devoted to improving the outcome after percutaneous coronary revascularization. In spite of refinements in techniques and pharmacologic therapy, which have resulted in an improved short-term angiographic and clinical outcome after percutaneous coronary interventions, long-term morbidity and mortality have not been shown to be significantly improved.³¹ Our results demonstrate that after successful percutaneous interventions, patients who continue to smoke have a 44 percent greater risk of death from any cause than those who quit smoking. Successful smoking-cessation programs

should thus be beneficial for patients who have undergone successful percutaneous coronary revascularization.

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