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Association Between Coronary Heart Disease Risk Factors and Physical Fitness in Healthy Adult Women

Larry W. Gibbons

Steven N. Blair
University of South Carolina - Columbia, sblair@mailbox.sc.edu

Kenneth H. Cooper

Mike Smith

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Association Between Coronary Heart Disease Risk Factors and Physical Fitness in Healthy Adult Women

LARRY W. GIBBONS, M.D., M.P.H., STEVEN N. BLAIR, P.E.D., KENNETH H. COOPER, M.D., M.P.H., AND MIKE SMITH, M.S.

SUMMARY We examined associations between physical fitness and risk factors for coronary heart disease in healthy women ages 18–65 years. Physical fitness was objectively determined by the duration of a maximal treadmill exercise test. Six physical fitness categories (very poor to superior), specific within 10-year age increments, were established. Mean risk factor levels varied across categories, but so did potential confounders such as age and weight. Multiple linear regression modeling was used to control for the effects of age, weight and year of exam on coronary risk factors. After adjustment, physical fitness was independently associated with triglycerides ($p < 0.001$), high-density lipoprotein cholesterol (HDL-C) ($p \leq 0.001$), total cholesterol/HDL-C ratio ($p \leq 0.001$), blood pressure ($p \leq 0.001$) and cigarette smoking ($p \leq 0.001$).

IT IS WELL ESTABLISHED that men have a higher incidence of cardiovascular disease than women. Nonetheless, coronary heart disease (CHD) is the leading cause of death in women (259 deaths/100,000 per year), with women in the United States having high rates compared with the rest of the world.[1] These statistics belie the relative paucity of research in CHD epidemiology in women. Available data, notably from the Framingham study, support the classic risk factor hypothesis for CHD in women. Women with higher levels of blood cholesterol, high blood pressure, and who smoke cigarettes are more likely to develop CHD than women without these risk factors.[2] Other presumed CHD risk factors have been less thoroughly studied in women. For example, several studies associating sedentary living habits with the incidence of CHD in men have been published,[3–5] but we are unaware of any such studies in women. Although the precise role of physical activity in the prevention of CHD is not known, a tenable hypothesis is that more active persons have lower levels of established risk factors. We previously showed that men who were more physically fit had lower levels of CHD risk than their less physically fit peers.[6]

The purpose of this paper is to examine the association between physical fitness and CHD risk factors in women. We hypothesized that women with higher levels of physical fitness have a lower CHD risk.

Methods

More than 3900 adult women, ages 18–65 years, were examined from 1971 to 1980. Some women received only a treadmill test, but 2854 received a complete physical examination, including CHD risk factor measurements. Most of these women were self-referred for the purpose of physical fitness evaluation, periodic health examination or receiving preventive medical advice. These patients tended to be well educated and from middle to upper socioeconomic strata. More than 99% of the women were white. Data reported in this paper are from the first clinic visit for these

From the Cooper Clinic and Institute for Aerobics Research, Dallas, Texas, and the School of Public Health, University of South Carolina, Columbia, South Carolina.

Address for correspondence: Larry W. Gibbons, M.D., Cooper Clinic, 12200 Preston Road, Dallas, Texas 75230.

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patients, and hence, represent a cross-sectional sample.

Presence of various diseases or conditions could affect both independent and dependent variables in this study. Therefore, only apparently healthy women were included in the data analysis. Criteria for inclusion in the study group are presented in table 1. Of the 2854 women who received the complete physical examination, 1074 were excluded for health reasons, based on the criteria listed in table 1. An additional 75 were excluded for failure to achieve at least 85% of the predicted maximal heart rate on the treadmill test. Thus, approximately 1700 healthy women were included in the analyses. The number in each specific analysis varies because of missing data. For example, high-density lipoprotein (HDL) cholesterol was measured beginning in 1978; hence, the number for these analyses is considerably smaller. Referral patterns and demographics of the population studied did not change during the course of the study, and all women, and not a subset of the population, had HDL cholesterol measured after the test became available. Thus, even though HDL cholesterol levels were higher in the latter portion of the study, we believe that this was due to an overall secular trend and not to a change in the type of person studied or the method or accuracy of laboratory measurement.

All tests and examinations were done at the Cooper Clinic in Dallas using standardized clinic procedures. Each subject gave informed consent. Patients reported to the clinic in the morning after a 12-hour fast; they were also asked not to smoke that day. Examinations were administered in an air-conditioned laboratory with a temperature of 22 ± 3 C°.

After completing a questionnaire on demographic information, health habits, and medical and family history, clinical and laboratory data were obtained. A venous blood sample was drawn and analyzed by automated procedures for blood lipids. Lipid measurements were calibrated against CDC standards. Total cholesterol levels were determined by the Technicon SMAC System (Technicon Instruments) using a modified Lieberman-Burchard method. Triglyceride levels were determined by the Technicon SMAC system using the method of Bucolo and David. HDL cholesterol levels were determined by precipitation of very low density lipoprotein (VLDL) and low-density lipoprotein (LDL) with sodium phosphotungstate in the presence of magnesium chloride at 0–4° C. The supernatant containing HDL was then analyzed by the ABA-100 (Abbott Laboratories Diagnostic Division) for HDL cholesterol using Abbott enzymatic cholesterol reagent (A-GENT). Body weight and height were obtained on a standard physician's scale with the patients nude. Body mass index (BMI) was calculated as weight/height^2 as an index of obesity. A resting ECG was taken with the patients in a recumbent position. Systolic and diastolic blood pressures (sitting position) were taken by trained technicians with mercury sphygmomanometers, which were periodically calibrated. Physical fitness was determined from a maximal treadmill test after a modified Balke procedure.[6] Five, seven or 15 leads were monitored during the exercise test. Patients were encouraged to continue the test to exhaustion. Some tests were stopped before exhaustion by the attending physician according to standard criteria. Patients with exercise ECG abnormalities and those who failed to continue the test to at least 85% of the age-adjusted predicted maximal heart rate were not included in the study.

TABLE 1. *Criteria for Inclusion in the Study*

Caucasian women ages 18–65 years	
No history of:	hypertension
	heart attack
	chest pain
	diabetes
	emphysema
	rheumatic fever
	heart murmur
	stroke
Normal resting and exercise ECG	
No evidence of cardiomegaly	
Achieved at least 85% of predicted age-adjusted maximal heart rate on the exercise test.	

The Cooper Clinic and the Institute for Aerobics Research (IAR) have standard age-adjusted physical fitness categories determined by treadmill time to exhaustion (table 2). These fitness categories are determined by percentile ranking of maximal treadmill time: 0–15% = very poor; 15–35% = poor; 35–65% = fair; 65–85% = good; 85–95% = excellent; and 95–100% = superior.

Questionnaire responses, clinical data and findings from the examination were processed by the data entry group at the IAR. Data were keyed and verified; errors and omissions were corrected before analysis.

Results

Descriptive data on selected variables are presented for each fitness category in table 3. Different numbers of subjects for the variables resulted from missing data for some individuals. Height did not differ across physical fitness groups, but the less fit women were relatively heavier, fatter and older. The number of individuals for each fitness level is included in table 3 to give an indication of the fitness distribution.

CHD risk factors by fitness level are presented in table 4. In general, women in the higher fitness categories had better risk factor profiles. Since there were several confounding variables that could possibly affect the fitness–risk factor association seen in table 4, further analyses were justified.

We adopted a multiple regession model to control for confounders and to isolate the fitness–risk factor association. Data from these analyses are presented in table 5. Initial analyses confirmed that age and BMI were associated with fitness levels and the dependent variables. We also noted a temporal effect with women examined during the latter part of the study period having more favorable risk factor profiles. Standard-

TABLE 2. *Definition of Fitness Categories for Females**

Fitness category	Age group (years) < 30	30–39	40–49	50–59	60+
Very poor	< 7:46	< 7:15	< 6:00	< 5:38	< 4:00
Poor	7:46–10:00	7:15–9:29	6:00–7:59	5:38–6:59	4:00–5:32
Fair	10:10–12:59	9:30–11:59	8:00–10:59	7:00–9:29	5:33–7:59
Good	13:00–15:59	12:00–14:59	11:00–12:59	9:30–11:59	8:00–10:59
Excellent	16:00–17:59	15:00–17:29	13:00–15:59	12:00–14:59	11:00–11:59
Superior	18:00+	17:30+	16:00+	15:00+	12:00+

*Based on the Cooper Clinic modified Balke treadmill protocol: 3.3 mph (90 m/min), 0% for first minute, 2% for second minute, +1% for each additional minute to 25%, then +0.2 mph until exhaustion.

ized regression coefficients for each independent variable for each of the risk factors are shown in table 5.

These coefficients indicate the association between each independent variable and each risk factor after statistically adjusting for the influence of the three other independent variables. The standardization of these coefficients means that they can be compared to determine which independent variable makes the greatest contribution to the R^2 for the full model. For example, the treadmill time coefficient for triglycerides (− 0.182) is larger than the coefficients for age (0.084), BMI (0.169), and exam year (− 0.056). This means that treadmill time is the independent variable most strongly associated with triglycerides. The sign of the coefficient indicates whether the association is direct (positive sign) or inverse (negative sign).

The full model includes treadmill time as the physical fitness variable in addition to age, BMI and exam year. The coefficients for age, BMI and exam year meet statistical significance on most risk factors; hence, control for these variables is justified in order to isolate the association between fitness and the risk factors. Treadmill time was significantly and independently associated with all risk factors except total cholesterol, confirming that most of the associations presented in table 4 were not due to confounding by age, BMI or exam year. The R^2 values for the full model for each risk factor and the probability that the correlation is significant are also included in table 5. The full model explains from 2–21% of the risk factor variance, and all correlations are statistically significant ($p < 0.001$). The final line of table 5 indicates the R^2 that can be independently attributed to treadmill time. Although treadmill time is significantly associated with all risk factors except total cholesterol, the relationship with systolic and diastolic blood pressures is relatively weak.

TABLE 3. *Physical Fitness Levels vs Age, Height and Weight*

Fitness level	Age (years) n = 1723	Height (cm) n = 1698	Weight (kg) n = 1706	Body mass index (kg/m²) n = 1698
Very poor				
Mean	39.7	164.6	67.6	24.9
± SD	±9.3	±5.7	±15.2	±5.3
n	159	158	158	158
Poor				
Mean	39.4	163.9	61.0	22.7
± SD	±10.6	±5.4	±10.0	±3.5
n	293	283	288	283
Fair				
Mean	39.5	164.5	59.5	21.9
± SD	±9.6	±5.6	±8.1	±2.7
n	444	440	441	440
Good				
Mean	39.6	164.6	57.4	21.2
± SD	±9.1	±5.8	±7.4	±2.2
n	439	432	443	432
Excellent				
Mean	41.0	164.8	56.8	20.9
± SD	±9.5	±5.8	±6.3	±1.9
n	218	216	217	216
Superior				
Mean	37.4	165.7	55.6	20.2
± SD	±9.3	±6.4	±6.0	±1.7
n	170	169	169	169

Although exam year was independently associated with the risk factors, including it in the regression model may serve to underestimate the association between treadmill time and the risk factors. Since a valid argument can be made for not adjusting for exam year, we computed another regression model with exam year excluded (table 6). The associations between treadmill time and risk factors in this model differ significantly from the full model for three variables. Treadmill time is now independently associated with total cholesterol and the standardized regression coefficients for systolic and diastolic blood pressure are significantly increased.

Adjusted mean values for the risk factors for each fitness level are presented in table 7. The means are adjusted for age, BMI and exam year by covariance analysis. Table 7 lists more detailed results of the regression model presented in table 5. The mean values for HDL cholesterol, the total cholesterol HDL cholesterol ratio (TC/HDL-C), triglycerides and percent smoking cigarettes show differences over the range of fitness levels. The trend for total cholesterol was nonsignificant; and the independent association between fitness and blood pressure, although statistically significant, was weak.

Alcohol intake has been associated with blood lipids and lipoproteins;[7] therefore, it seemed advisable to control for this in our analysis. A brief dietary pattern questionnaire was completed by 1093 of the women in this study. Participants were queried about intake of

TABLE 4. *Physical Fitness Levels vs Coronary Risk Factors*

Fitness level	Total cholesterol (mg/dl) n = 1678	Triglycerides (mg/dl) n = 1672	HDL cholesterol (mg/dl) n = 744	TC/HDL-C ratio n = 744	Blood pressure (mm Hg) Systolic n = 1689	Blood pressure (mm Hg) Diastolic n = 1689	Current cigarette smokers % n = 1723
Very poor	(n = 153)	(n = 153)	(n = 59)	(n = 59)	(n = 152)	(n = 152)	(n = 159)
Mean ± SD	204±39	107±72	52±15	4.0±1.6	116±14	77±9	20
Poor	(n = 283)	(n = 283)	(n = 79)	(n = 79)	(n = 289)	(n = 289)	(n = 293)
Mean ± SD	201±37	93±57	53±12	3.8±1.2	113±14	75±10	24
Fair	(n = 433)	(n = 431)	(n = 169)	(n = 169)	(n = 433)	(n = 433)	(n = 444)
Mean ± SD	200±37	82±46	56±11	3.6±0.9	112±13	74±9	16
Good	(n = 430)	(n = 427)	(n = 211)	(n = 211)	(n = 431)	(n = 431)	(n = 439)
Mean ± SD	196±35	76±42	59±13	3.3±0.8	109±12	73±9	13
Excellent	(n = 213)	(n = 212)	(n = 122)	(n = 122)	(n = 215)	(n = 215)	(n = 218)
Mean ± SD	195±35	70±29	61±12	3.2±0.7	110±11	74±9	11
Superior	(n = 166)	(n = 166)	(n = 104)	(n = 104)	(n = 169)	(n = 169)	(n = 170)
Mean ± SD	194±31	65±26	61±12	3.2±0.6	108±11	73±8	8

Abbreviations: HDL = high-density lipoprotein; TC/HDL-C = ratio of total cholesterol to HDL cholesterol.

beer, wine and hard liquor. An alcohol index (drinks/week) was calculated by summing the drinks/week for each of the three alcohol categories. This variable was added to the regression model for the four lipid risk factors in our study. Alcohol intake was not independently associated with total cholesterol or triglycerides but was significantly associated with HDL cholesterol ($p < 0.002$) and TC/HDL-C ($p < 0.02$). The R^2 for this expanded model increased from 0.11 to 0.14 for HDL cholesterol and from 0.19 to 0.22 for TC/HDL-C. Treadmill time remained as a significant independent correlate for HDL cholesterol ($p < 0.006$) and TC/HDL-C ($p < 0.0006$) in this expanded model with adjustment for alcohol intake. The adjusted mean values (table 7) for HDL cholesterol and TC/HDL-C fitness category do not change appreciably with additional adjustment for alcohol intake.

We also examined the effect of cigarette smoking on the risk factor analyses. Multiple regression analyses were done for each of the risk factors with number of cigarettes/day added to the regression model. These analyses were done on the approximately 1700 healthy women included in the analysis in tables 5, 6 and 7. The results were not changed. The independent effect of cigarette smoking was not statistically significant in any of the analyses.

We recognize that the extensive inclusion and exclusion criteria applied in this study truncate distribution of the risk factors. This conservative approach was adopted in an attempt to avoid spuriously high associations that might be caused by correlation between preexisting disease, the risk factors and physical fitness. For example, a person with a history of disease might very well be less likely to engage in regular exercise and, thus, have a low level of physical fitness. This person would also be more likely to have elevated risk factors. Leaving such persons in the analysis would likely cause higher correlations between treadmill time and risk factors and lead to faulty conclusions. For similar reasons, patients with less than 85% of age-adjusted maximal heart rate on the treadmill test were excluded. If the test were stopped early, before the patient achieved maximal performance, the estimate of fitness would be invalid. Patients who stop the test early would be more likely to have disease and concomitantly poorer risk factor status. Thus, we believe our conservative approach to data analysis is likely to reduce bias.

TABLE 5. *Multiple Regression Analyses on Coronary Risk Factors*

Independent variables	Risk factors: Total cholesterol n = 1675	Triglycerides n = 1668	HDL cholesterol n = 747	TC/HDL-C n = 747	Blood pressure: Systolic n = 1820	Blood pressure: Diastolic n = 1820	Current smokers n = 1856
Age	0.355†	0.084†	0.223†	0.052	0.267†	0.212†	−0.088†
BMI	0.105†	0.169†	−0.213†	0.261†	0.130†	0.107†	−0.085†
Exam year	−0.218†	0.056*	−0.036	−0.001	−0.216†	−0.140†	0.009
Treadmill time	0.004	−0.182†	0.141†	−0.160†	−0.064*	−0.062*	−0.174†
R^2 for full model	0.21†	0.12†	0.11†	0.14†	0.19†	0.11†	0.02†
R^2 for treadmill time	NS	0.023†	0.013†	0.018†	0.003*	0.003*	0.021†

Values are standardized regression coefficients.
*$p < 0.05$.
†$p < 0.001$.
Abbreviations: BMI = body mass index; HDL = high-density lipoprotein; TC/HDL-C = ratio of total cholesterol to HDL cholesterol.

TABLE 6. *Multiple Regression Analysis on Coronary Risk Factors With Exam Year as an Independent Variable*

Independent variables	Total cholesterol n = 1675	Triglycerides n = 1668	HDL cholesterol n = 747	TC/HDL-C n = 747	Blood pressure Systolic n = 1820	Blood pressure Diastolic n = 1820	Current smokers n = 1856
Age	0.355†	0.084†	0.226†	0.052	0.268†	0.212†	−0.088†
BMI	0.092†	0.116†	−0.211†	0.261†	0.120†	0.100†	−0.085†
Treadmill time	−0.053*	−0.196†	0.143†	−0.160†	−0.115†	−0.095†	−0.172†
R^2 for full model	0.17†	0.12†	0.11†	0.14†	0.14†	0.09†	0.02†
R^2 for treadmill time	0.002†	0.028†	0.028†	0.018†	0.010†	0.007†	0.021†

Values are standardized regression coefficients.
*$p < 0.05$.
†$p < 0.001$.
Abbreviations: BMI = body mass index; HDL = high-density lipoprotein; TC/HDL-C = ratio of total cholesterol to HDL cholesterol.

After data were analyzed on the healthy patients, we performed several analyses on the nonexcluded group of approximately 2800 women who had the complete evaluation. Patients excluded because of failure to achieve the heart rate criterion had lower treadmill times and poorer risk factor profiles ($p < 0.05$). Full regression models were calculated for each risk factor on the group before exclusions, and the F value for the independent effect of treadmill time was approximately the same as the corresponding F value obtained in the same analyses on the healthy women. The regression analysis was also repeated separately on the 1100 women who were excluded. The results were consistent with the other regression analyses; fitness was independently associated with risk factors. Thus, our findings from the different analyses are congruent, and the main findings reported for the healthy women do not appear to be due to sampling or selection bias within our population.

Since some of the risk factor distributions were not entirely normal, we repeated the regression analysis on both the healthy women and the entire group with the risk factors adjusted by log transformation. There were no significant differences between the adjusted and nonadjusted analyses. The data reported here are on the nonadjusted values.

Discussion

The association between treadmill time as a measure of cardiovascular fitness and several important CHD risk factors does not, of course, establish a relationship between fitness and changes in those risk factors. Previous studies have documented an association between exercise and improved CHD risk factors, and other studies have provided some evidence that regular activity may be associated with a decreased CHD incidence.[3–6] The present study differs from these previous studies in two important respects. First, this study deals with fitness and risk factors in women; the preponderance of previously published data in this area has dealt with men. Second, this study uses an objective and accurate measurement of physical fitness — the symptom-limited maximal treadmill test — rather than questionnaire or submaximal exercise tests with extrapolated estimates of maximum endurance.

Exam year (1971–1980) was included as an independent variable when it became clear in data analysis that women examined in the later years of the study had more favorable risk factor profiles. (Table 6 includes the same analysis without exam year as an independent variable.) This temporal improvement in risk factor status was true for triglycerides, HDL cholesterol, TC/HDL-C, smoking and blood pressure. Since the mean age and socioeconomic status in women did not change significantly during the study, the improved coronary risk status might be a general phenomenon in the population as a whole and might be present in both men and women. This offers one plausible, though unsubstantiated, explanation for the drop in CHD death rates in the United States during the last decade.[8]

Our previous cross-sectional study of total cholesterol levels and fitness in men shows a small but sig-

TABLE 7. *Adjusted* Means for Selected Risk Factors by Physical Fitness Group*

Fitness level	Total cholesterol (mg/dl) n = 1657	Triglycerides (mg/dl) n = 1657	HDL cholesterol (mg/dl) n = 744	TC/HDL-C ratio n = 747	Blood pressure (mm Hg) Systolic n = 1657	Blood pressure (mm Hg) Diastolic n = 1657	Now smoke cigarettes (%) n = 1651
Very poor	19	98	56	3.7	114	76	23
Poor	197	90	54	3.7	112	75	24
Fair	199	82	57	3.6	111	73	16
Good	197	78	58	3.4	110	73	12
Excellent	196	72	59	3.3	111	74	9
Superior	202	72	60	3.3	111	74	5

*Means adjusted for age, body mass index and exam year.
Abbreviations: HDL = high-density lipoprotein; TC/HDL-C = ratio of total cholesterol to HDL cholesterol.

nificant inverse relationship.[6] This current study in women does not, unless exam year is excluded. The majority of investigators who have looked at fitness and total cholesterol failed to find significant association when appropriate adjustment for age and weight were made.[9–13]

There is much more evidence for an association of triglyceride levels with fitness than for total cholesterol and fitness.[6, 10, 14] Most of this evidence, however, comes from work done in men. Our data show a strong correlation in women.

There is a significant amount of cross-sectional data relating higher levels of HDL cholesterol to higher levels of physical activity in men.[15–17] Some longitudinal and experimental data exist as well that support such an association.[14, 18] In the only previous study done in women examining the relationship between HDL cholesterol levels and measured fitness, Haskell et al.[13] found no significant association, but they did report a significant relationship between physical activity reported by questionnaire and HDL cholesterol levels.[13] Some of their fitness measurements were based on submaximal estimates; but even when only maximal test data were examined, no relationship was found. Thus, their data[13] are in clear conflict with ours. Our population of volunteers, who for the most part were health-conscious, well educated, highly motivated women, were perhaps encouraged to give a more nearly maximal effort on treadmill testing, which might separate fitness levels more widely and more accurately. In general, our population is undoubtedly more active than that of Haskell et al., and this may have allowed for greater variation in treadmill times and, hence, greater opportunity to show a relationship. The consistent dose-response association between HDL cholesterol levels and fitness, the persistence of the association despite control for potential confounding variables, and the supporting data from other authors for a strong relationship of HDL cholesterol and fitness in men support our findings that measured physical fitness is related to HDL cholesterol levels in women.

The strongest association with fitness among the risk factors we have studied was the relationship between fitness and TC/HDL-C. Some investigators believe that this ratio may be the best predictor of CHD risk among all of the blood lipid indexes.[19]

A few longitudinal studies have demonstrated decreases in systolic and diastolic blood pressure in response to endurance exercise programs, but change in blood pressure documented in most studies is modest.[20, 21] The evidence that exercise lowers blood pressure independent of changes in weight and salt intake is not overwhelming. Showing a significant association between blood pressure and fitness has characteristically been much more difficult in normotensive than hypertensive persons.[22] In our study, those with a history of hypertension were excluded. Thus, it is not surprising that only small differences in blood pressure according to fitness levels were recorded in this population of very healthy women. These differences were present, however, and did reach levels of significance. When exam year is excluded as an independent variable, the association is stronger.

The demonstrated association between fitness and lower rates of smoking is interesting but not surprising. Smoking, especially heavy smoking, would be expected to limit maximal exercise performance to some extent. On the other hand, runners may be encouraged to stop smoking as a result of starting and maintaining exercise programs, although the data are not consistent.[23] Persons who are sufficiently health-conscious to avoid tobacco or to stop smoking may also be more likely to be engaged in an exercise program.

Even though these associations between fitness and various CHD risk factors are statistically significant, the amount of variance in risk factors accounted for by fitness was small in these healthy women. Of course, the influence of fitness on CHD may, for the most part, be independent of effects on risk factors. Other studies in men suggest there is a strong independent protective effect of fitness.[3, 4]

The associations between fitness and CHD risk factors discussed in this paper should be examined in a longitudinal setting before definitive conclusions can be drawn. When more data are gathered, if fitness does prove to have a significant effect on these important risk factors, that relationship could have a definite influence on the risk of CHD in the United States population of women, considering the large numbers of previously sedentary women who have recently become physically active.

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Value and Limitations of Computed Tomography in Assessing Aortocoronary Bypass Graft Patency

WERNER G. DANIEL, M.D., WILFRIED DÖHRING, M.D., HANS-STEPHAN STENDER, M.D., AND PAUL R. LICHTLEN, M.D.

SUMMARY To determine the value of nondynamic computed tomography (CT) in assessing aortocoronary bypass graft patency, we studied 67 patients with 125 grafts by CT and by coronary angiography at close time intervals. CT scans were performed before and after one to three (average 1.98 ± 0.65) 50-ml i.v. bolus injections of contrast material. Eighty-four of 92 grafts patent at angiography were also visualized by CT (sensitivity 91.3%); 29 of 33 grafts closed at angiography were considered to be occluded by CT (specificity 87.9%). Eleven of 13 grafts demonstrating one or more severe obstructions at angiography were considered to be patent by CT. Interobserver disagreement existed in four of 125 grafts (3.2%) and intraobserver variability was 1.6%. Although nondynamic CT allows a correct assessment of graft patency in many cases, it does not provide sufficient information on graft stenosis and function to replace angiography in patients who are symptomatic after surgery.

ACCURATE determination of aortocoronary bypass graft patency requires angiography. Noninvasive methods for analyzing bypass grafts function, such as the directional Doppler flow technique,[1] thallium-201 myocardial perfusion scintigraphy[2–4] and echocardiographic analysis of regional ventricular function,[5] are of limited value because they indirectly assess bypass graft patency. A noninvasive method easily performed, repeatable and without special risks, visualizing the anatomy and providing direct information on graft patency, would be very useful in the postoperative evaluation of patients after bypass graft surgery. Computed tomography (CT) provides a high-resolution, cross-sectional image of the chest and may be an ideal tool for noninvasive evaluation of aortocoronary bypass grafts.[6–16] However, the merits and limitations of this method need to be defined. In the studies so far published, the number of investigated grafts are often small, angiographic controls of the results are not always available, and clinical correlations are often lacking.

Therefore, in a consecutive series of patients who underwent postoperative coronary angiography for persistent or recurrent angina pectoris, CT scanning was also performed to assess bypass graft patency in close temporal relation to angiography. A conventional nondynamic scanner was used because it is the type most commonly available.

From the Division of Cardiology, Department of Internal Medicine, and the Department of Radiology, Hannover Medical School, Hannover, West Germany.

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Address for correspondence: Werner G. Daniel, M.D., Division of Cardiology, Department of Internal Medicine, Hannover Medical School, Konstanty-Gutschow-Str. 8, D-3000 Hannover 61, West Germany.

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Materials and Methods

Patients and Angiography

From October 1979 to February 1981, 67 consecutive patients (65 males and two females), ages 40–67 years, who underwent angiographic assessment of graft patency because of recurrent postoperative chest pain were entered into the study. All patients gave written, informed consent for CT investigation and coronary angiography. One hundred twenty-five grafts