ORIGINAL ARTICLE

Functional Status May Serve as a Predictor of CABG Surgery Outcome in the Elderly Patient

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ABSTRACT

Despite the growing number of elderly patients undergoing coronary artery bypass graft (CABG) surgery, no study addressing postoperative outcome from the perspective of preoperative functional status has been reported to date. The present investigation therefore undertook to determine, among elderly individuals matched for cardiac status, whether patients with poor functional status have a greater risk of mortality and morbidity following CABG surgery than those with good functional status. Retrospective preoperative and postoperative geriatric functional assessment using a standardized questionnaire was performed on 46 consecutive patients who had undergone CABG in 1994 at age 65 or older. Preoperative functional status was comprised of pre-anginal functional status (before angina limited physical activity) and anginal functional status (during which angina was a noticeable limiting factor). CABG outcome was recorded in terms of postoperative assessment of functional status, morbidity, and mortality. The results of statistical analysis revealed that both pre-anginal and anginal functional status were sensitive predictors of post-operative functional status ($p < 0.005$ and $p < 0.001$, respectively). In addition, the presence of comorbidities typically used in the screening of candidates was found to be a sensitive predictor of outcome ($p < 0.02$). However, the presence of comorbidities was not significantly linked to poor preoperative functional status ($p > 0.05$), indicating that these two predictors may screen for different elderly sub-populations at high risk for negative outcome of CABG. If confirmed by further studies of elderly patients undergoing CABG, these results suggest a new and important role for functional status as a predictor of CABG outcome in the elderly. Furthermore, these results may be useful toward the development of a reliable tool in screening for high risk of poor outcome among elderly candidates for CABG surgery.

INTRODUCTION

The elderly population is the fastest growing segment in North America. Since the incidence of atherosclerosis normally increases with age, this population also has the highest incidence of coronary artery

disease (CAD). Overall, CAD is the principal cause of death in two out of three geriatric patients. These facts, as well as the increase in longevity of the elderly population and the technological progress achieved in coronary artery bypass graft (CABG) surgery, have led, over the past 15 years, to an increase in the average age of patients undergoing cardiac surgery from 50 to 62 (1).

Few studies to date have effectively compared the medical versus surgical management of the elderly patient with heart disease; therefore, surgeons have traditionally relied on clinical intuition in selecting elderly candidates for CABG. The rising number of elderly patients in whom CABG is indicated, and the increasing limitations on health care resources, require a new and more rational approach to the selection of surgical candidates, with greater emphasis on the likelihood of benefit from surgery. Although elderly and younger candidates may have similar preoperative cardiac conditions, the incidence of non-cardiac preoperative comorbidities such as diabetes, chronic obstructive pulmonary disease (COPD), hypertension, previous stroke, and renal insufficiency is significantly higher in the older patients (2-5). Such preoperative comorbidities may affect CABG outcome.

Studies in general surgery and intensive care have revealed that preoperative or pre-admission functional status of the geriatric patient is related to the incidence of postoperative complications and mortality. Categorizing limited functional status by evidence in patient medical records of prior difficulty or dependency with respect to basic daily activities, Mayer-Oakes found that ICU patients with a limited functional status were approximately three times more likely to die in hospital, or within six months of the ICU admission, than patients without functional limitations (6). In addition, older patients without functional limitations were no more likely to die following ICU admission than their younger counterparts (6). In a study of fitness as a predictor of postoperative complications in elderly patients undergoing general surgery, Pringle and Seymour determined that active patients, defined as those who typically left their home at least twice a week through their own efforts, had significantly reduced risks of life-threatening postoperative complications when compared to non-active patients (7).

Despite the above findings in general surgery and ICU settings, no comparable study of functional status has been undertaken in elderly patients undergoing CABG. In addition, although several mathematical models have been designed to predict mortality following CABG with relative accuracy using cardiac status and co-existing morbidities (8,9,10), the mortality predicted for a given patient has varied by up to nine fold among different models (11). It is quite possible that the discrepancy between actual outcome and the outcome predicted by the various mathematical models may be due in part to a difference in individual functional status given the same cardiac status.

Prior research on CABG outcome, including that utilizing mathematical models, has largely evaluated mortality risk, disregarding quality of life after surgery. Clearly, however, the objective of CABG is not only to increase longevity, but also to lengthen the active life expectancy, defined by independence in performing activities of daily living (12). This latter objective has yet to be adequately investigated. Accordingly, the purpose of the present study was to determine, among individuals matched for cardiac status, whether elderly patients with poor preoperative functional status are at increased risk for post-CABG mortality and morbidity relative to those with good functional status.

MATERIALS AND METHODS

Retrospective preoperative and postoperative geriatric functional assessment using a standardized questionnaire was performed on 46 consecutive patients who had undergone CABG in 1994 at age 65 or older. Patients selected to undergo CABG were males and females of New York Heart Association (NYHA) angina class I-IV who had failed to obtain satisfactory results in terms of quality of life with medication alone, and those with left coronary stenosis greater than 50%, with or without angina. CABG was performed according to standard procedures using either a reverse saphenous vein or an internal mammary artery for the

bypass graft (13). Outcome of CABG was recorded in terms of postoperative assessment of functional status, morbidity, and mortality, and the relationship between preoperative assessment and postoperative outcome was statistically measured as described below. Possible confounding variables known to increase postoperative risk were also measured, and are noted below.

Assessment of Functional Status

Preoperative and postoperative functional status were assessed using Seymour and Pringle's Level of Activity Test (7) and a standardized questionnaire adapted from Pryori's Angina Form 9.1 (14). The former test consisted of determining the number of times per week that the patient left the home independently. Those patients indicating a frequency of two or more were designated as active, and all others as non-active. In the questionnaire adapted from Pryor (Table 1), any combination of responses yielding a total score ¾ 15 was considered good functional status, whereas 16 or more indicated poor functional status. The present authors selected a cutoff of 15 *a priori* based on reasonable expectations for good functional status in elderly patients. Preoperative functional status was stratified into pre-anginal and anginal functional status, such that the above two methods of assessment were used to address functional status both prior to and after the date of first onset of the patient's anginal symptoms. Post-operative functional status referred to status two years postoperatively. In cases wherein patients died as a result of complications during or following surgery, or before the end of the two-year postoperative period, the pertinent information was obtained from relatives, patient charts, and the surgeon who performed the procedure. The mortality rate related to CABG was calculated as the mortality rate within 30 days postoperatively.

It should be noted here that although most patients had experienced an exacerbation of CAD symptoms in the few months before CABG, some reported never having experienced classical symptoms of angina, nor any noticeable loss of function more than a week prior to surgery. For this group of patients, overall preoperative status was considered equivalent to the pre-anginal status. By contrast, for those patients who reported feeling limited by angina through a period of more than two years prior to surgery, overall preoperative status was determined to be the anginal status.

Confounding Variables

In addition to functional status, the presence of comorbidities and other risk factors known to influence the outcome of CABG was recorded at interview and via consultation of the patient's chart. Significant comorbidities used in risk calculation were prior history of stroke, chronic renal failure, and chronic heart failure. The presence of two or more of the following was also considered a significant risk factor and was included in the category of comorbidities for the purpose of analysis: obesity (as defined by a body mass index >= 28 kg/m^2), diabetes, chronic obstructive pulmonary disease, peripheral vascular disease, cerebrovascular disease, and hypertension. Other known risk factors, such as class of angina, age, and gender, were independently assessed. Smoking, an additional important risk factor, could not be reliably ascertained.

Statistical Analysis

Chi-square analysis and Student's *t*-test were used to determine the correlations between predictors and outcome. The predictors tested were pre-anginal and anginal functional status scores, activity according to the Pringle and Seymour test, presence of comorbidities, class of angina, age, and gender. The outcomes were post-operative functional status, presence of serious post-operative complications, and death. To simplify the calculations, patients who died intraoperatively or during the postoperative period were given a functional status score of 30, the poorest score on the scale used. All statistical analyses were performed using SPSS software. A likelihood ratio with p ¾ 0.05 was considered significant.

RESULTS

In the population studied, consisting of eight females and 38 males (17% and 83%, respectively), patient age ranged from 65 to 85 years and averaged 71 years, with five patients (11%) >= 75 years of age. Significant comorbidities, as defined above, were present preoperatively in 18 patients (39%). The CABG mortality rate was 4.4%, representing two patients who had died within 30 days postoperatively. Two additional patients had died within the two-year postoperative period, such that the two-year survival rate was 91%. Five patients (11%) had experienced serious complications within 30 days following the operation.

In the Seymour and Pringle test using activity level as a predictor of outcome, 44 of the 46 patients declared having left the home through their own efforts at least two times per week during each preoperative period; this information was unavailable in the remaining two cases. None of the assessed postoperative outcomes showed significant correlation with patient designation as either active or non-active based on this test.

Data pooled from the functional status questionnaire adapted from Pryor is presented in Table 2 in terms of the number of patients ascribed good and poor functional status during the pre-anginal, anginal, and postoperative periods. The results of statistical analysis of the functional status questionnaire data are shown in Tables 3 and 4. Pre-anginal functional status, anginal functional status, and the presence of significant comorbidities were found to be significant predictors ($p < 0.05$) of some, but not all, post-surgical outcomes. Class of angina, by contrast, did not correlate significantly with any of the post-surgical outcomes studied.

In addition to the correlations reported in Tables 3 and 4, the presence of post-surgical complications was significantly associated with both death and poor functional status as outcomes ($p < 0.05$ for each). Furthermore, no significant association between the presence of comorbidities and either pre-anginal or anginal functional status was found ($p = 0.32$ and $p = 0.15$, respectively).

DISCUSSION

The results as summarized above highlight several predictors of CABG outcome. A favorable outcome was evaluated not only in terms of survival or longevity, but also by the absence of severe complications and the degree of functional status, which is closely related to quality of life as defined earlier. Statistical analysis revealed that the presence of one or more comorbidities was a sensitive predictor of mortality and complications following CABG, as well as of poor postoperative functional status. Significant comorbidities used in risk calculations were prior history of stroke, chronic renal failure, and chronic heart failure. The presence of two or more of the following risk factors also constituted a significant comorbidity for the purpose of analysis: obesity (as defined by a body mass index >= $28 kg/m^2$), diabetes, chronic obstructive pulmonary disease, peripheral vascular disease, cerebrovascular disease, and hypertension.

The Seymour and Pringle Activity Level Test failed to be a good predictor of surgery outcome, proving insufficiently sensitive for this type of study. This result may indicate that the high-risk patients for CABG surgery identified by the test have already been screened out through more basic selection processes. By contrast, both pre-anginal and anginal functional status were found to be sensitive predictors of postoperative functional status. Although the functional status and the presence of comorbidities were both found to be good predictors, the latter was demonstrated to be statistically unrelated to functional status in both the pre-anginal and anginal preoperative periods. This indicates that patients with comorbidities and those with poor functional status may represent two different populations at risk for diminished quality of life following CABG. One explanation for this result may be that the population with poor functional status in the absence of a comorbidity consists of patients with reduced physical fitness due to the normal process of aging. In this regard, it should be noted that the aging process varies among individuals with the same age, and therefore chronological age should not be considered equivalent to functional status as a predictor of post-CABG outcome. Another possibility is that the high-risk comorbidities screened for in the elderly differ from those screened for in younger patients; since the guidelines for screening high-risk populations have been designed for younger patients, comorbidities present in the elderly may be missed through the traditional comorbidity

assessment.

Quite importantly, post-operative functional status scores did not differ significantly from pre-anginal functional status scores ($p > 0.05$) in patients with poor pre-anginal functional status. Average pre-anginal and postoperative functional status scores in this group of patients were 19.7 and 21.2, respectively. This finding raises the question as to whether these patients should be excluded from CABG. Part of the answer lies in comparing the outcome in poor functional status patients exclusively treated by medications to the outcome in those treated surgically. Moreover, in the present study, the class of angina failed to prove a reliable predictor of CABG outcome. This result is supported by prior investigations suggesting that, while the outcome of medical therapy is related to the patient's class of angina, the outcome of CABG is not (15). Kirklin explains this finding by the fact that the severity of angina reflects the magnitude of coronary artery obstruction, which the bypass graft, unlike medication, essentially eliminates uniformly (13).

The results of the present study also indicate that poor pre-anginal functional status correlates with the presence of post-CABG complications. This finding is important, as it suggests that pre-anginal functional status may be of use in predicting postoperative complications, which have been shown to be associated with an increase in death rate, a reduction in quality of life, and a longer duration of hospitalization following CABG surgery, with an attendant increase in cost.

Despite the finding that anginal functional status is not a statistically significant predictor of post-CABG complications, all patients experiencing complications proved to have a poor anginal functional status. The same phenomenon was observed with pre-anginal and anginal functional status as predictors of mortality. Despite a statistically non-significant correlation, all patients who died either in the month after or within two years following CABG had poor pre-anginal functional status, and three of four also had poor anginal functional status. These results certainly suggest a trend to be further investigated in a study of increased sample size. Although the sample was relatively small (n = 46) in the present study, the sample was representative of the general population undergoing CABG in such respects as 30-day mortality rate and proportion of women operated (4% and 17%, respectively), which compare favorably with those reported in larger-scale studies (3,4,6).

There is an emergent trend in the literature to subclass elderly patients into two different populations in terms of potential risks for CABG (16,17): the young elderly, aged between 65 and 75, and the old elderly, aged 75 and above. In some studies, age > 75 was found to be a predictor of significantly increased mortality following CABG (1,2,17). Unfortunately, the present study involved only five patients over the age of 75, such that age was not used here as a predictor of outcome. However, analysis by Student's *t*-test demonstrated that these patients did not have significantly different
pre-anginal and postoperative functional status than their younger counterparts. This finding suggests that functional status is not tightly related to age and/or that functional status played a heightened role in patient selection for CABG in these individuals. As the over-75 population has a short life expectancy independent of surgery, it appears logical in this age group to select treatment that promises an increased likelihood of maintaining quality of life, rather than to establish a goal of extended longevity.

In summary, this study shows that functional status and the presence of comorbidities are sensitive predictors of CABG outcome in the elderly patient. It was also concluded that functional status and comorbidity are independent variables that screen for different populations at risk for unfavorable CABG outcome. Further investigations using a larger sample size are warranted to support the results found here, as well as to examine the impact of sex, age, and class of angina on the outcome of CABG. An increased sample size may also be more sensitive to the difference between classes of angina as predictors of surgery outcome. Finally, the potential utility of functional status in the prediction of length of stay in hospital, which is directly related to the cost of CABG (18), is of important interest from both the clinical and financial perspectives of patient care. A study of this is currently underway.

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REFERENCES

1. Loop FD, Lytle BW, Cosgrove DM, et al. Coronary artery bypass graft surgery in the elderly: indications and outcome. Cleveland Clinic Journal of Medicine 55(1): 22-23; 1988.

2. Mohan R, Walter PJ, Vandermast M, et al. Isolated coronary artery bypass grafting in patients 75 years of age and older; is age per se a contraindication? Thoracic Cardiovascular Surgeon 40: 365-370; 1992.

3. Gold S, Wong WF, Schatz IJ, et al. Invasive treatment for coronary artery disease in the elderly. Archives of Internal Medicine 5: 1085-1088; 1991.

4. Fuse K, Makoochi H. Early and late results of coronary artery bypass grafting in the elderly. Japanese Circulation Journal 52: 460-465; 1988.

5. Kurki TSO, Kataja M. Preoperative predictor of postoperative morbidity in coronary artery bypass grafting. Annals of Thoracic Surgery 61: 1740-5; 1996.

6. Mayer-Oakes SA, Oye RK, Leake B. Predictors of mortality in older patients following medical intensive care: the importance of functional status. Journal of the American Geriatric Society 39: 862-868; 1991.

7. Seymour DG, Pringle R. Postoperative complications in the elderly surgical patient. Gerontology. 29: 262-270; 1983.

8. Edwards FH, Peterson RF, Bridges C, et al. 1988: Use of a bayesian statistical model for risk assessment in coronary artery surgery. updated in 1995. Annals of Thoracic Surgery 59(6): 1611-1612; 1995.

9. O'Connor GT, Plume SK, Amstead EM, et al. Multivariate prediction of in-hospital mortality associated with coronary artery bypass surgery. Northern New England cardiovascular disease study group. Circulation 85(6): 2110-2118; 1992.

10. Higgins TL, Estafanous FG, Loop FD, et al. Stratification of morbidity and mortality outcome by preoperative risk factors in coronary artery bypass patients: a clinical severity score. JAMA 267: 2344-2348; 1992.

11. Orr RK, Maini BS, Sottile FD, et al. A comparison of four severity-adjusted models to predict mortality after coronary artery bypass graft surgery. Archives of Surgery 130: 301-306; 1995.

12. Katz S, Branch LG, Brandon MH, et al. Active life expectancy. New England Journal of Medicine 309: 1218; 1983.

13. Kirklin JW, Akins CW, Blackstone EH, et al. Guidelines and indications for coronary artery bypass graft surgery. Journal of the American College of Cardiology 17(3): 543-89; 1991.

14. Stewart AL, Hays RD, Ware JE Jr. The MOS short-form general health survey. Reliability and validity in a patient population. Medical Care 26(7): 724-35; 1988.

15. Myers WO, Shaff HV, Gersh BJ, et al. Improved survival of surgically treated patients with triple vessel

coronary disease and severe angina pectoris. A report from the coronary artery surgery study (CASS) Registry. Journal of Thoracic Cardiovascular Surgery 97: 487-495; 1989.

16. Mohan R, Amsel BJ, Walter PJ. Coronary artery bypass grafting in the elderly-A review of studies on patients older than 60, 69, or 74 years. Cardiology 80: 215-225; 1992.

17. Hannan EL, Burke J. Effect of age on mortality in coronary artery bypass surgery in New York, 1991-1992. American Heart Journal 128(6): 1184-1191;1994.

18. Lahey SJ, Borlasc BC, Lavin PT, et al. Preoperative risk factors that predict length of stay in coronary bypass patient >60 years old. Circulation. 86(5 Suppl.): II 181-5; 1992.

BIOGRAPHY

Chantal Mayer received her B.Sc. in Physiology from McGill University (Montreal, Quebec, Canada) in 1995. She is currently a second-year medical student at McGill. Her work on functional status as a predictor of CABG outcome in the elderly was conducted following her first year of medical education.