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16. Abstract

The identification of risk factors for adverse cardiac events is valuable to the certification of airmen. This study examines the importance of right bundle branch block (RBBB) as a risk factor for myocardial infarction (MI), atherosclerotic heart disease (ASHD) and coronary heart disease (CHD).

Using a non-concurrent prospective design, 433 Class I airmen between the ages of 35 and 60 years who had an RBBB on their electrocardiogram (ECG) in 1970 were matched to 338 control Class I airmen who had no abnormalities on their 1970 ECG. Using the longitudinal database maintained by the Federal Aviation Administration (FAA), the medical records of these airmen were screened for MI, ASHD, and CHD through the end of 1985. Questionnaires were sent to airmen with incomplete data on the computerized database.

The first occurrence of any of these outcomes was considered an adverse cardiac event. In the case group, 24 cardiac events occurred (3.93/1,000 person-years) compared with 9 events in the control group (1.87/1,000 person-years). The relative risk was 2.012 with 95% confidence intervals of .994 to 4.484. The ChiSquare for independence was 3.85 1 df, $p<0.05$.

The findings suggest an increased risk of adverse cardiac events but are of borderline statistical significance.

17. Key Words
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RIGHT BUNDLE BRANCH BLOCK AS A RISK FACTOR FOR SUBSEQUENT CARDIAC EVENTS

INTRODUCTION

The Federal Aviation Administration (FAA) grants pilots Class I medical certificates for flight based on the results of medical examinations conducted by one of the 2,700 physicians designated as Class I aviation medical examiners (AMEs). After reaching the age of 35 years, in addition to the routine medical examination, pilots applying for Class I certification are required to have a resting 12-lead electrocardiogram (ECG). This longitudinal assessment of electrocardiographic findings makes it possible to identify airmen who should receive intensive cardiovascular evaluations before medical certificates are granted.

Right bundle branch block (RBBB), a ventricular conduction defect, is defined as a QRS interval (ventricular depolarization) of greater than or equal to 0.12 seconds in Lead V1 (right chest lead). This conduction defect is considered by the FAA to be an electrocardiographic abnormality of importance requiring the assignment of a pathology identification number. The specific aim of this study is to compare the risk of receiving a diagnosis of myocardial infarction (MI), atherosclerotic heart disease (ASHD) or coronary heart disease (CHD) in airmen holding Class I medical certificates with complete RBBB on routine resting ECG to the risk experienced by Class I airmen without this ECG abnormality.

Methods

To examine the relationship between RBBB and the development of subsequent MI, ASHD or CHD, a non-concurrent prospective study was designed. The study population of male Class I pilots between the ages of 35 and 60 years was defined as of December 31, 1970. From this population of 35,617 aviators, 433 Class I airmen between 35 and 60 years of age who had a complete RBBB as of December 31, 1970, on a resting ECG performed during the medical certification examination were identified. This represents a point prevalence rate of RBBB of 12.16 per 1,000 Class I pilots between the ages of 35 and 60 years (Table 1).

Table 1

Point Prevalence Rates of RBBB Among Class I Airmen By Age December 31, 1970

Age Group	Class I Airman Population	No. of Airmen with RBBB	Point Prevalence per 1,000 Airmen
35 - 39	11,481	61	5.40
40 - 44	7,134	92	12.90
45 - 49	8,957	146	16.30
50 - 54	6,079	103	16.90
55 - 59	1,966	31	15.80
Total	35,617	433	12.16

These cases were matched within 5 years of age to 338 male Class I airmen without an RBBB. These study subjects were followed for the occurrence of a cardiac event through December 31, 1985.

As a result of the ongoing medical examination process required for certification of pilots, the FAA has a large, relatively complete, longitudinal database on Class I airmen. This database, known as the airman history file, contains results of all medical certification examinations and ECGs. These results are forwarded from AME offices to the FAA's Aeromedical Certification Division (AMCD), where they are coded, compiled and

stored on computer tape as part of the airman history file. The computerized airman history file was the major source of data for this study.

Twenty-nine percent of the case group and 28 percent of the control group identified in 1970 did not maintain medical certification through the end of 1985 although they were less than 60 years of age at the end of the follow-up period. If cardiac event experience was related to this failure to apply for recertification, a significant bias in the results would occur. To address this issue, a questionnaire was sent to this subgroup to determine their cardiac event experience through the end of 1985. In the event of a deceased or incapacitated study subject, the next of kin were instructed to complete the questionnaire to the best of their ability.

The cases and controls were compared at the beginning of the study period to cardiovascular disease risk factors on which information is routinely collected. These factors were blood pressure, weight, and cardiac abnormalities. Age, an important cardiovascular risk factor in itself, was the only variable on which the cases and controls were matched. The mean age of the RBBB cases was 47.5 years while the mean age of the control group was 46.9 years.

Height and weight were used to calculate body mass index (BMI) at the beginning of the study period for each of the study subjects. The mean BMI for the case group was 25.43 and 25.59 for the control group. West (10) has proposed an ideal BMI for males measured with light clothing and no shoes of 22.4. Using the definition of obesity as 20% above the ideal BMI, 27% of both case and control groups were obese.

"Definite hypertension" is defined by the FAA as a blood pressure exceeding 160/98. The mean blood pressure for both the case and control groups was 125/78. Neither case nor control group had any members who fell into the hypertensive category, a finding which is not surprising, given the several medications approved by FAA for blood pressure control and the fact that this group is a highly-screened occupational population.

At baseline, the cases were characterized as to their cardiac risk profile using their ECG abnormalities and the pathology codes assigned them by the AMCD. The distribution of baseline cardiac risk factor profiles among the cases is shown in Table 2. Thirteen percent of the cases of RBBB also had other conditions such as ischemic electrocardiographic changes, arrhythmias, changes in cardiac chamber size and axis deviation, which may affect cardiac outcome experience. Eighty-seven percent of the cases had only RBBB with no known other electrocardiographic abnormalities or conditions that would affect their outcome. The control group had no known electrocardiographic abnormality or cardiovascular conditions that would alter their risk.

Table 2

Baseline Risk Factor Profile Categories

RISK CATEGORIES	No.	Percent
Uncomplicated RBBB	377	87
RBBB with evidence of ischemia	8	2
RBBB with arrhythmia	5	1
RBBB with chamber size changes	17	4
RBBB with axis deviation	16	4
RBBB with other conduction defects	3	1
RBBB with diabetes mellitus	3	1
RBBB with other conditions	4	1

With respect to the cardiac risk factors on which the FAA routinely collects data, the RBBB cases and controls were very similar. A summary of the risk factors of the case and control groups is shown in Table 3. Data on study subjects' smoking behavior and serum cholesterol levels were not available for analysis

Table 3

Summary of Baseline Characteristics of RBBB Cases and Controls

	RBBB Cases	Controls
Mean Age	47.5 years	46.9 years
Body Mass Index	25.43	25.59
Percent Obese	27%	27%
Mean Blood Pressure	125/78	125/78
Percent with Other Known Cardiovascular Conditions	13%	0%

The follow-up of the cases began with the first visit at which the RBBB was noted during or prior to 1970. Controls were followed from their latest 1970 exam. Beginning the control group follow-up later than cases dilutes somewhat the benefit of age matching and, therefore, the person years contributed by this group.

To address this issue, the person-years of experience contributed by each control was increased by 2.5 years. The 2.5 years represent the mean number of years between the date on which the RBBB is first noted in the case group and the last examination in 1970.

For the cases and controls, the response rates to the mailed questionnaire were 56% and 50% respectively. Of the completed questionnaires, 73% were completed by the airman, 22% by the airman's spouse, 2% by the airman's offspring and 3% by others. With the information from the questionnaire, complete data for the study period were available for 85% of the cases and 83% of the controls.

Among the pilots not responding to the questionnaires, 49% were returned by the postal system because the pilot was no longer at the most current address of which the FAA had knowledge. Forty-eight percent of the mailed questionnaires were not returned by either the airman, his next-of-kin or the postal system. Three percent were found to have new information on the FAA database; therefore, this information was used in lieu of questionnaire data.

Of the cases who were sent a questionnaire and did not respond, 88% had only the RBBB at baseline, while 12% had other cardiovascular conditions, in addition to the RBBB. The mean age at baseline of the non-respondents was 47.6 years and they were followed a mean of 5.8 years before they were lost to follow-up. Among the non-respondents in the RBBB case group, six had cardiac events that occurred before they were lost to follow-up. In these cases, information from the questionnaire, if completed, would have added little to the study. In the control group, no cardiac events were experienced before they were lost to follow-up. At baseline, the subgroup of the airmen who did not have complete information on the airman history file and did not respond to the questionnaire were similar to those for which complete information was available.

A "cardiac event" was defined as pathology codes on the airman history file indicating the diagnosis of myocardial infarction, atherosclerotic heart disease, or coronary heart disease. For those airmen with incomplete data for the study period on the history file,

responses on the questionnaire were used to determine their cardiac outcome experience. A cardiac event, which was ascertained from the questionnaire, was defined as reported history of myocardial infarction, coronary heart disease, angina or atherosclerotic heart disease.

Followup of the cases and controls was accomplished using the computerized airman history file and the follow-up questionnaire sent to pilots with incomplete data on the history file. The mean length of follow-up for the case group was 14.2 years with a range of 1 month to 21.6 years, compared to a mean of 14.3 years for the control group. Length of follow-up in the control group ranged from 1 month to 16 years.

RESULTS AND DISCUSSION

Twenty-four cardiac events were experienced by the 433 cases with RBBB (6%), while the control group of 338 pilots experienced 9 events (3%). This increased proportion of cardiac events in RBBB cases compared to the controls was of borderline statistical significance with a ChiSquare = 3.85, 1 df, $p<.05$. Of the 24 events occurring in the case group, 10 (42%) were myocardial infarction, and 14 (58%) were coronary heart disease and/or atherosclerotic heart disease with or without angina pectoris. Among the cases who had myocardial infarction, one had coronary artery bypass surgery. Two of the cases with coronary artery disease had bypass surgery. Of the nine events occurring in the control group, five (56%) were myocardial infarction and four (44%) were coronary heart disease and/or atherosclerotic heart disease, with or without angina. Among those controls with coronary artery disease, one pilot had coronary artery bypass surgery.

Owing to the unequal length of follow-up for the cases and controls, person-years of observation were used as the denominators for the calculation of incidence rates. The incidence rate of cardiac events in the case group was 3.93 per 1,000 person-years of observation, compared with an incidence rate of 1.87 per 1,000 person-years of observation in the control group. The relative risk was 2.012 (95% confidence limits: .994-4.484) (3).

Current literature on cardiac outcomes among aviators with RBBB does not support a role for RBBB as a risk factor for subsequent cardiac outcomes. Among those studies (2,6,8) that examined the risk of cardiac outcomes in military aviator populations, RBBB was not found to be a significant predictor of cardiovascular events in an asymptomatic population. In Rabkin's study (4) of sudden death among Royal Canadian Air Force pilots and pilots licensed by the Canadian Department of Transportation, no increased risk of sudden death was noted among the 65 pilots with an RBBB. In the study of civilian aviators in Argentina by Canaveris (1), no excess risk of adverse cardiac outcomes was demonstrated.

The findings of the present study of cardiovascular outcomes in the Class I airmen are not inconsistent with the findings of the previous studies. Although our risk ratio is elevated, the 95% confidence interval includes the value 1.

Among the descriptive studies that examined RBBB in aviators, the prevalence rates in the study population varied. Hickman (2) found a prevalence of RBBB in USAF pilots under the age of 50 years to be six per 1,000 pilots. Canaveris (1) reported a prevalence rate of 5.9/1,000 pilots. In the present FAA study, the point prevalence rate was 12.16 per 1,000 Class I pilots. The differences in the prevalence rates are likely to be a function of the different populations studied and certification or eligibility criteria.

The computerized medical history and ECG file maintained by the FAA provided a unique opportunity to examine the role of RBBB in the subsequent development of selected cardiac outcomes in a large civilian aviator population. Unfortunately, information on two of the most important cardiovascular risk factors, serum cholesterol level and smoking, is not available from the airman history file. While the case and control groups are comparable with respect to the covariates on which we have data, it cannot be determined

from this study if any excess risk of cardiac events experienced by the case group is a result of the RBBB, or is in fact related to one of the risk factors on which we have no data.

CONCLUSIONS

The data suggest an increased risk for the subsequent development of cardiac event in the RBBB cases, compared to the age-matched controls. This apparent elevated risk is an interesting finding, although inconclusive. The borderline significance of the test of independence of the RBBB and the cardiac events, as well as the interval estimates for the relative risk which are inclusive of one, suggest further in-depth examination is necessary. A portion of the cohort of RBBB cases and controls that has been identified could possibly be evaluated in terms of serum cholesterol levels and smoking behavior. An analysis that adjusts for the influence of these covariates would more clearly determine the role of RBBB as a risk factor for subsequent cardiac events.

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