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Incidence of and Risk Factors for Bundle Branch Block in Adults older than 40 years

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Background : In the general population, the incidence of bundle branch block (BBB) is relatively low, and its effects on long-term prognosis have not been established. Previous studies on the incidence and correlation of BBB to clinical factors have produced conflicting results. However, the incidence of BBB was strongly related to age. This study aimed to describe the incidence of and risk factors for BBB in Korea.

Methods : In this study, 14,540 adults (male 6,573/female 7,967) ≥40 years old received screening tests for general health between April and December 2000. Participants answered questionnaires and underwent examinations, which included blood pressure, electrocardiogram (ECG), total cholesterol and fasting glucose. The data analysis was performed using SPSS 10.0 for windows.

Results : The incidences of complete right bundle branch block (CRBBB) were 1.5 and 2.9% in people older than 40 and 65 years, respectively. Approximately 38.0% of individuals with CRBBB were older than 65 years. The incidence of CRBBB was higher in men than women at all age groups was highest in those aged 75-79 years. Males, advancing age (>65 years), hypertension and diabetes mellitus (DM) were associated with an increased risk of CRBBB. The incidences of complete left bundle branch block (LBBB) and bifascicular bundle branch block (BBBB) were 0.1 and 0.08% and 0.3 and 0.2% in those older than 40 and 65 years, respectively. Approximately 71.4 and 58.3% of individuals with LBBB and BBBB, respectively, were older than 65 years. Advancing age and cardiac disease were associated with an increased risk of LBBB. Advancing age was associated with an increased risk of BBBB. The most potent risk factor for BBB in this study was advancing age.

Conclusion : The incidences of BBB were 1.7 and 3.4% in those older than 40 and 65 years respectively. Bundle branch block correlates strongly with age, and is common in the older ages groups. These findings support the theory that bundle branch block is a marker of slowly progressing degenerative diseases.

Key Words : Bundle branch block; Incidence; Risk factors

INTRODUCTION

In the general population, the prevalence of bundle branch block is relatively low, and its effects on long-term prognosis have not been established. Investigations on the incidence of and risk factors for BBB have also yielded conflicting results. Fahy et al.[1] reported an overall prevalence of 0.3% for bundle branch block (right or left). In the Reykjavic study[2, 3], the prevalence of LBBB and RBBB were 0.4 and 0.28% and 4.1 and 1.6% in men and women, respectively, aged 75-79 years old. In men younger than 60 years, RBBB had significant relationships with hypertension, elevated fasting glucose and increased heart size. There was a relationship between hypertension and RBBB in women younger than 60 years. The

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Tecumseh study[4] showed the prevalence of bundle branch block to be 2.4% in men > 50 years old. In the Framingham study[5], complete intraventricular block (QRS interval greater than or equal to 0.12 second) was strongly related to age, with a prevalence of 11 and 5% in elderly men and women, respectively. In all these population studies, BBB was more common among men than women, right-side block was more frequent than left-side block, but an increased mortality was not observed, with the exception of patients who had coronary artery disease.

Erikson et al.[6] found the prevalence of BBB increased from 1 to 50% between the ages of 50 and 80 years in men, but no significant relationship with ischemic heart disease or mortality. Men at risk of developing BBB had bigger heart volumes at age 50 years and developed diabetes mellitus and congestive heart disease during follow-up to a greater extent than the control subjects. These investigators concluded; BBB correlates strongly to age, was common in elderly men and its development was related to slowly progressive degenerative diseases of the conducting system.

In contrast with the good prognosis for complete bundle branch block in the general population, the appearance of new bundle branch block during acute myocardial infarction is associated with poor early and long-term prognoses. In two recent studies[7, 8], bundle branch block, particularly new and permanent, was an independent predictor of increased mortality; whereas old or transient bundle branch blocks were associated with only a slightly increased risk of mortality. Among patients with acute myocardial infarction, right bundle branch block is more common than left bundle branch block.

Hesse et al.[9] reported in their 6.7 year follow-up that right and left bundle branch blocks were associated with increased mortality. Patients with right bundle branch block were older, more likely to be male, and had coronary artery and pulmonary disease more frequently than those without. Patients with left bundle branch block were also older, but included more women.

In Korea, the incidence of and risk factors for BBB were not evaluated. This study aimed to describe the incidence of and risk factors for BBB in Koreans.

MATERIALS AND METHODS

In our study, 14,540 adults (male 6,573/female 7,967) ≥ 40 years old inhabitants of 5 cities and 3 counties in Gyeongsangnam-do received screening tests for general health between April and December 2000 by a National Health Insurance Cooperation. All participants answered questionnaires on history of medical illness (hypertension, DM, and cardiovascular disease), smoking and alcohol drinking, and underwent examinations including blood pressure, electrocardiogram (ECG), total cholesterol and fasting glucose.

Blood sampling was performed after a fasting state of at least 12 hours. Plasma total cholesterol and glucose were measured in an autoanalyzer (Automatic analyzer, Hitachi 736-20, Japan) by enzymatic and glucose-oxidase methods. The 12-lead resting ECG was performed using an Auto Cardiner FCP-2201, FCP-2155 (Fukuda Denshi Co. Japan). Hypertension was defined as a systolic blood pressure of at least 140 mmHg or a diastolic blood pressure of at least 90 mmHg on each of two readings, according to the Joint National Committee criteria VI (JNC VI)[10], or by the use of antihypertensive medication. Diabetes mellitus was diagnosed if the subjects had a fasting glucose level equal to or higher than 126 mg/dL, according to the ADA (American Diabetes Association) diagnostic criteria[11], or the taking of insulin or an oral hypoglycemic agent at the time of the examination. Hypercholesterolemia was diagnosed if the subjects had a serum total cholesterol level equal to or higher(than 240 mg/dL, according to the NCEP III (National Cholesterol Education Program III) criteria[12].

Clinical cardiovascular disease at the baseline was defined by any of the following: a history of myocardial infarction, angina pectoris, heart failure, valvular heart disease, cardiomyopathy, and stroke. Alcohol drinking was ascertained by self-report and categorized as the weekly alcohol consumption > 90 g ethanol (Soju 1 bottle/week). CRBBB was defined as (1) QRS duration ≥ 120 ms, (2) PQ interval > 120 ms, (3) rSR' in lead V_1 or V_2 and (4) S wave in lead I and either of leads V_5 or V_6. LBBB was defined as (1) QRS duration ≥ 120 ms, (2) PQ interval > 120 ms, (3) predominantly upright complexes with slurred R waves in leads I, V_5 and V_6 and (4) QS or rS pattern in lead V_1. They were further classified according to the QRS axis, i.e. < -30 degrees or > +90 degrees indicating a possibility of a bifascicular block (concomitant a left or right anterior hemiblock. The statistical analysis was performed using SPSS 10.0 (Statistical package for the social sciences, SPSS Inc, Chicago, IL, U.S.A.) for Windows and correlation analysis by chi-square tests, contingency coefficients and Cramer's V. Multivariate analysis was performed by a multinominal logistic regression test. A p value < 0.05 was considered statistically significant.

RESULTS

A total of 14,540 subjects (6,573 men and 7,967 women), with a mean age 54.6±10.8 of years, ranginge from 40 to 92, were enrolled in our study. Table I lists the numbers of participants according to age and gender.

The incidences of BBB were 1.7 (242/14,540) and 3.4%

Table 1. Numbers of participants according to age & gender

Age Groups (years)	Total (%)	Male (%)	Female (%)
40 - 49	5,576 (38.4)	2,491 (37.9)	3,085 (38.7)
50 - 59	3,920 (27.0)	1,830 (27.8)	2,090 (26.2)
60 - 64	2,168 (14.9)	988 (15.0)	1,180 (14.8)
65 - 69	1,237 (8.5)	518 (7.9)	719 (9.0)
70 - 74	1,095 (7.5)	480 (7.3)	615 (7.7)
75 - 79	369 (2.5)	177 (2.7)	192 (2.4)
≥ 80	175 (1.2)	89 (1.4)	86 (1.1)
Total	14,540 (100)	6,573 (100)	7,967 (100)

Table 2. Incidence of CRBBB according to age & gender

Age Groups (years)	Total (%)	Male (%)	Female (%)
40 - 49	38 (0.7)	23 (0.9)	15 (0.5)
50 - 59	45 (1.1)	26 (1.4)	19 (0.9)
60 - 64	51 (2.4)	28 (2.8)	23 (1.9)
65 - 69	30 (2.4)	15 (2.9)	15 (2.1)
70 - 74	32 (2.9)	17 (3.5)	15 (2.4)
75 - 79	15 (4.1)	9 (5.1)	6 (3.1)
≥ 80	5 (2.9)	3 (3.4)	2 (2.3)
Total	216 (1.5)	121 (1.8)	95 (1.2)

* % = numbers of CRBBB/numbers of participants

Table 3. Incidence of LBBB according to age & gender

Age Groups (years)	Total (%)	Male (%)	Female (%)
40 - 49	1 (0.02)	1 (0.04)	0 (0.00)
50 - 59	1 (0.03)	1 (0.05)	0 (0.00)
60 - 64	2 (0.09)	1 (0.10)	1 (0.08)
65 - 69	3 (0.24)	2 (0.39)	1 (0.14)
70 - 74	2 (0.18)	1 (0.21)	1 (0.16)
75 - 79	2 (0.54)	0 (0.00)	2 (1.04)
≥ 80	3 (1.71)	2 (2.25)	1 (1.16)
Total	14 (0.10)	8 (0.12)	6 (0.08)

* % = numbers of LBBB/numbers of participants

Table 4. Incidence of BBBB according to age & gender

Age Groups (years)	Total (%)	Male (%)	Female (%)
40 - 49	2 (0.04)	1 (0.04)	1 (0.03)
50 - 59	1 (0.03)	0 (0.00)	1 (0.05)
60 - 64	2 (0.09)	1 (0.10)	1 (0.08)
65 - 69	2 (0.16)	1 (0.19)	1 (0.14)
70 - 74	4 (0.37)	2 (0.42)	2 (0.33)
75 - 79	0 (0.00)	0 (0.00)	0 (0.00)
≥ 80	1 (0.57)	0 (0.00)	1 (1.16)
Total	12 (0.08)	5 (0.08)	7 (0.09)

* % = numbers of BBBB/numbers of participants

(99/2,876) in those older than 40 and 65 years, respectively. Approximately 89.3% (216/242) of individuals with BBB were CRBBB, and 5.8 (14/242) and 5.0% (12/242) were LBBB and BBBB, respectively. The mean age of those with LBBB was 69.1 years old, which was older than other groups.

The incidences of CRBBB) were 1.5 (216/14,540) and 2.9% (82/2,876) in those older than 40 and 65 years, respectively. The incidences in men and women were 1.8 (121/6,573) and 1.2% (95/7,967), respectively, in people older than 40 years. The mean age of individuals with CRBBB was approximately 61.1 ± 10.8 years. The incidence of CRBBB was 1.5-fold higher in men than in women. The incidences of CRBBB were 0.7, 1.1, 2.4, 2.9, 4.1 and 2.9% in those aged 40-49, 50-59, 60-64, 65-69, 70-74, 75-79 and older than 80 years, respectively. The incidence of CRBBB was higher in all age groups for men than women. Approximately 38.0% (82/216) of individuals with CRBBB were older than 65 years. Also, the incidence of CRBBB was highest in the 75-79 years age group. Table II lists the incidences of CRBBB according to age groups and sexgender.

The incidences of complete left bundle branch block (LBBB) were 0.1 (14/14,540) and 0.3% (10/2,876) in those older than 40 and 65 years, respectively. The incidences in men and women were 0.12% (8/6,573) and 0.08% (6/7,967), respectively, in people older than 40 years. The mean age of individuals with LBBB was approximately 69.1 ± 9.7 years. Approximately 71.4% (10/14) of individuals with LBBB was older than 65 years. Also, the incidence of LBBB was highest in people older than 80 years. Table III lists the incidence of LBBB according to age groups and gender.

The incidences of bifascicular bundle branch block (BBBB) were 0.08 (12/14,540) and 0.2% (7/2,876) in those older than 40 and 65 years, respectively. The incidences in men and women were 0.08 (5/6,573) and 0.09% (7/7,967), respectively, in people older than 40 years. The mean age of individuals with BBBB was approximately 63.8 ± 13.2 years. The incidence of CRBBB and left anterior hemiblock and left posterior hemiblock were 91.7 (11 subjects, men 5 and women 6) and 8.3% (1 subject, men 1), respectively. Approximately 58.3% (7/12) of individuals with BBBB were older than 65 years. Also, the incidence of BBBB was highest in men aged 70-74 years and women older than 80 years. Table IV lists the incidence of BBBB according to age groups and gender.

Advancing age (≥ 65 years) (p=0.0000), male (p=0.0016), hypertension (p=0.0016) and DM (p=0.0015) were significantly associated with an increased risk of CRBBB. However, hypercholesterolemia (p=0.3671), cigarette smoking (p=0.8153), alcohol drinking (p=0.9676), cardiac disease (p=0.9763) and stroke (p=0.6146) were not associated with an increased risk of CRBBB (Table 5).

Advancing age (p=0.0000) and cardiac disease (p=0.0000) were associated with an increased risk of LBBB. Advancing

Table 5. Analysis of risk factors for CRBBB

Risk factors	ECG (n)*	C. coefficient†	Cramer's V	χ^2 (p value)
Age (years)				
≥ 65	82/2794	0.0553	0.0553	0.0000
40 - 64	134/11530			
Sex				
Male	121/6452	0.0261	0.0261	0.0016
Female	95/7872			
Hypertension				
+	61/2780	0.0262	0.0262	0.0016
−	155/11544			
Diabetes mellitus				
+	20/643	0.0263	0.0263	0.0015
−	196/13681			
Hypercholesterolemia				
+	18/1498	0.0075	0.0075	0.3671
−	198/12826			
Smoking				
+	32/2239	0.0019	0.0019	0.8153
−	184/12085			
Alcohol drinking				
+	35/2302	0.0003	0.0003	0.9676
−	181/12022			
Cardiac disease				
+	5/336	0.0004	0.0004	0.9763
−	211/13988			
Stroke				
+	3/120	0.0042	0.0042	0.6146
−	213/14204			

* ECG (n); Numbers of CRBBB/ no CRBBB group
† C. coefficient; contingency coefficient

age (p=0.0028) was associated with an increased risk of BBBB, but gender (p=0.5292), hypertension (p=0.6062), DM (p=0.8592), hypercholesterolemia (p=0.3627), cigarette smoking (p=0.8175), alcohol drinking (p=0.8557) and stroke (p=0.2663) were not associated with an increased risk of LBBB. Also, gender (p=0.9652), hypertension (p=0.4001), DM (p=0.9479), hypercholesterolemia (p=0.8141), cigarette smoking (p=0.2743), alcohol drinking (p=0.7360), cardiac disease (p=0.1704) and stroke (p=0.2089) were not associated with an increased risk of BBBB (Table 6, 7).

After adjustment for age, gender and other clinical variable, the independent risk factors for RBBB were found to be old age (odds ratio, OR 2.4; 95% confidence interval [CI] : 1.8 to 3.2; p=0.000), diabetes (OR 1.9; 95% CI: 1.2 to 3.1; p=0.006), male (OR 1.7; 95% CI: 1.3 to 2.3; p=0.001) and hypertension (OR 1.4; 95% CI: 1.0 to 1.9; p=0.042). Also, independent risk factors for LBBB were old age (OR 8.6; 95% CI: 2.6 to 28.5; p=0.000) and cardiac disease (OR 18.2; 95% CI: 5.8 to 57.4; p=0.000). The only independent risk factor for BBBB was old age (OR 5.0; 95% CI: 1.5 to 16.5; p=0.007) (Table 8).

DISCUSSION

Several studies have shown that both left and right bundle branch block are associated with increased mortality among patients with heart disease, particularly those with myocardial infarction[13-15]. In the general population, however, the prevalence of bundle branch block is relatively low, and its effects on the long-term prognosis have not been established. Also, investigations of the incidence of and risk factors for BBB have yielded conflicting results.

In our study, the incidences of BBB were 1.7 and 3.4% in those older than 40 and 65 years, respectively. The incidences of CRBBB were 1.5 and 2.9% in those older than 40 and 65 years, respectively. The incidences in men and women were

Table 6. Analysis of risk factors for LBBB

Risk factors	ECG (n)*	C. coefficient†	Cramer's V	χ^2 (p value)
Age (years)				
≥ 65	10/2866	0.0374	0.0375	0.0000
40 - 64	4/11660			
Sex				
Male	8/6565	0.0052	0.0052	0.5292
Female	6/7961			
Hypertension				
+	4/2837	0.0043	0.0043	0.6062
−	10/11689			
Diabetes mellitus				
+	1/662	0.0015	0.0015	0.8592
−	13/13864			
Hypercholesterolemia				
+	3/1513	0.0075	0.0075	0.3627
−	11/13013			
Smoking				
+	3/2268	0.0019	0.0019	0.8175
−	11/12258			
Alcohol drinking				
+	3/2334	0.0015	0.0015	0.8557
−	11/12192			
Cardiac disease				
+	5/336	0.0682	0.0682	0.0000
−	9/14190			
Stroke				
+	0/123	0.0092	0.0092	0.2653
−	14/14403			

* ECG (n): Numbers of LBBB/ no LBBB group
† C. coefficient: contingency coefficient

Table 7. Analysis of risk factors for BBBB

Risk factors	ECG (n)*	C. coefficient†	Cramer's V	χ^2 (p value)
Age (years)				
≥ 65	7/2869	0.0248	0.0248	0.0028
40 - 64	5/11659			
Sex				
Male	5/6568	0.0004	0.0004	0.9652
Female	7/7960			
Hypertension				
+	4/2837	0.0070	0.0070	0.4001
−	8/11691			
Diabetes mellitus				
+	1/662	0.0005	0.0005	0.9479
−	11/13866			
Hypercholesterolemia				
+	1/1515	0.0020	0.0020	0.8141
−	11/13013			
Smoking				
+	0/2271	0.0091	0.0091	0.2743
−	12/12257			
Alcohol drinking				
+	1/2336	0.0028	0.0028	0.7360
−	11/12192			
Cardiac disease				
+	1/340	0.0113	0.0113	0.1704
−	11/14188			
Stroke				
+	1/122	0.0104	0.0104	0.2089
−	11/14406			

* ECG (n): Numbers of BBBB/ no BBBB group
† C. coefficient: contingency coefficient

Table 8. Multinominal logistic regression test by adjusted risk factors for BBB

Risk factors	Odds ratio	95% Confidence interval	*p* value
RBBB			
Age ≥ 65 years	2.4	1.8 - 3.2	0.000
Diabetes	1.9	1.2 - 3.1	0.006
Male	1.7	1.3 - 2.3	0.001
Hypertension	1.4	1.0 - 1.9	0.042
LBBB			
Cardiac disease	18.2	5.8 - 57.4	0.000
Age ≥ 65 years	8.6	2.6 - 28.5	0.000
BBBB			
Age ≥ 65 years	5.0	1.5 - 16.5	0.007

1.8 and 1.2%, respectively, in people older than 40 years. The incidence of CRBBB was 1.5-fold higher in men than women. The incidence of CRBBB was higher in all age groups in men than women. The incidences of LBBB were 0.1 and 0.3% in people older than 40 and 65 years, respectively. The incidences in men and women were 0.12 and 0.08%, respectively, in people older than 40 years. The incidences of BBBB were 0.08 and 0.2% in those older than 40 and 65 years, respectively. The incidences in men and women were 0.08 and 0.09%, respectively, in people older than 40 years. Our results explain the wide prevalence range noted in earlier trials and show that BBB is highly age-dependent.

The etiology of BBB in subjects without evidence of structural heart disease is usually an age-related degeneration of the conducting system, which may be either a focal (Lev's disease)[16] or diffuse (Lenegre's disease)[17] process. This process is a result of mechanical trauma on the conduction system, leading to microtrauma of the proximal raminifications of the bundle branch system. A clinically unapparent episode of myocarditis with residual impairment of intraventricular conduction may be an etiologic factor in both right and left bundle branch block subjects[18]. Two points support this hypothesis: first, the majority of patients in the present series with acquired bundle branch block reported histories of prolonged flu-like illness in the year preceding their ECG abnormality; secondly, angiographic and hemodynamic data on patients with acquired right and left bundle branch block with no clinically apparent cardiovascular disease have revealed a mild diffuse abnormality of the ventricular myocardium manifested by elevation of left ventricular end-diastolic pressure. Others may have undetected ischemic or valvular heart disease or cardiomyopathy.

In the Framingham study[19], an increased risk of subsequent development of coronary heart disease or congestive heart failure was shown in men who developed left bundle branch block. When adjusted for age, this difference was not significant. In women, however, the clinical correlations of the two conduction abnormalities were similar. The high prevalence rate of antecedent hypertension suggests that it may often play a central role in the pathogenesis of both types of block. Hypertension predisposes to the development of bundle branch block, primarily by potentiating the development of generalized myocardial fibrosis, sclerosis of the left side of the cardiac skeleton or primary sclerodegenerative changes of the bundle branches themselves, by predisposing to the development of coronary atherosclerosis with resultant ischemic damage to the bundle branches or by another as yet undefined process.

From the Coronary Artery Surgery Study[20], on 15,609 patients with coronary artery disease, 522 were identified with bundle branch block. Patients with bundle branch block had both more extensive coronary artery disease and worse left ventricular function than those without. However, no particular location of coronary artery stenosis or left ventricular wall motion abnormality predominated in patients with bundle branch block, indicating that the bundle branch block was the result of infarction of the proximal conduction system.

The marked increase in mortality in patients with bundle branch block is seen only in combination with ischemic heart disease. In bundle branch block, the depolarization phase is, by definition, prolonged. Furthermore, the prolongation of the vulnerable repolarization phase in combination with an increased number of premature ventricular beats (secondary to ischemic heart disease) would expose the patient to an increased risk of sudden ventricular tachyarrhythmias[6].

This theory is supported by electophysiological studies of patients with bifascicular block, in whom sustained monomorphic ventricular tachycardia was induced exclusively in patients with a previous myocardial infarction[21]. Furthermore, McAnulty et al.[22] followed up 554 patients with bundle branch block and noticed an increased risk of sudden death due, not to bradyarrhythmia, but rather to tachyarrhythmias and myocardial infarction. Another explanation[6] of the high mortality from acute myocardial infarction could be a degenerative cardiomyopathy less able to compensate for a sudden loss of functional myocardium during the course of an acute myocardial infarction.

It is not clearly why complete bundle branch block is associated with a higher risk of death. Pathological and physiological studies have shown this finding to correlate with fibrosis of the conduction system[23-25], which may contribute to left ventricular contractile asynergy[20] bradyarrhythmias and tachyarrhythmias[26, 27].

In our study, advancing age, male, hypertension and DM were significantly associated with an increased risk of CRBBB. Advancing age and cardiac disease were associated with an

increased risk of LBBB. Advancing age was associated with an increased risk of BBBB. The most potent risk factor of BBB was advancing age. Therefore, it is recommend that physicians have a high threshold for further investigating or referring patients with RBBB. Conversely, patients with LBBB have an increased risk of developing overt cardiac disease, and warrant closer consideration for more extensive investigation and follow-up.

In conclusion, bundle branch block correlates strongly to age, and is common in older age groups. These findings support the theory that bundle branch block is a marker of slowly progressing degenerative diseases.

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