Comparison of the Prevalence of Ventricular and Supraventricular Premature Beats with 24-hour Holter Electrocardiography between Hypertensive and Normotensive Shift Workers in a Manufacturing Company

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Abstract: We conducted 24-hour Holter electrocardiography (ECG) among shift workers to assess whether there were differences in the prevalence of ventricular and supraventricular premature beats between hypertensive (HT) and normotensive (NT) workers. Among the selected 24 male shift workers, 20 were fitted with 24-hour Holter ECG monitors. Nine workers were in the HT group and 11 the NT group. The prevalence of isolated supraventricular premature beats (SVPBs) and SVPB runs were higher in the HT group than in the NT group, but without statistical significance. The prevalence of ventricular premature beats (VPBs) was similar between groups. One worker in each group experienced ≥ 720 VPBs per 24 hours, while the worker in the HT group was detected as having a short run of VPBs. The results suggested the necessity of a larger scale study to clarify an association between hypertension and arrhythmias using 24-hour Holter electrocardiography.

Key words: Arrhythmia, Supraventricular premature beats, Ventricular premature beats, Shift workers, 24-hour monitoring, Holter electrocardiography, Hypertension

There is some evidence from studies done in Japan and other countries¹⁻⁸⁾ that shift work that involves night work is associated with higher incidence of cardiovascular disease.

Knutsson⁴⁾ followed 504 papermill workers for 15 years to determine higher incidence of ischemic heart disease (IHD) in shift workers. They reported that the relative risk (RR) of IHD increased with the exposure to shift work; the RR was 2.2 and 2.8 with exposures of 11 to 15 years and of 16 to 20 years, respectively. Bøggild *et al.*⁹⁾ reviewed 17 studies of the incidence of cardiovascular disease in shift workers and found the risk was 1.4 times that of daytime workers.

Morikawa *et al.*²⁾ reported a study of 1551 young shift workers in which the incidence of hypertension was 3 times higher than in an age-matched cohort of daytime workers.

In the workplace, resting electrocardiograms (ECGs) are often performed as part of a routine medical examination intended to detect or prevent cardiovascular diseases. However, because these ECGs are done at rest for short duration, their ability to detect arrhythmias is minimal. By conducting longer duration ECG measurements, the possibility of detecting arrhythmias is likely to be increased.

Holter ECG monitors are well known^{10, 11)} in the performance of continuous ECG measurements and have gained widespread use globally in identifying cardiac

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Table 1. Characteristic of subjects

	number	Age (yr.)	SBP (mmHg)	DBP (mmHg)	BMI (kg/m ²)
Hypertensive group	9	44.1 ± 7.7	162.2 ± 20.6	103.1 ± 8.3	24.4 ± 2.1
Normotensive group	11	41.8 ± 5.8	124.7 ± 6.0	76.3 ± 5.5	25.0 ± 3.6

BMI=Body Mass Index. The values are expressed as the mean ± SD except the number.

arrhythmias. However, there has been only one study using Holter monitoring as a means of clarifying the relationship between shift work and ventricular premature beats (VPBs). Harenstam¹²⁾ found that night work had an association with VPBs frequency and shift work tended to show an association with VPBs frequency.

Green *et al.*¹³⁾ suggested that systolic and diastolic blood pressure had a significant correlation with VPBs. Blackburn *et al.*¹⁴⁾ reported that both the incidence and frequency of VPBs were associated with only systolic blood pressure. Furthermore Rodstein *et al.*¹⁵⁾ found that the presence of VPBs together with hypertension resulted in increased mortality.

Therefore, to clarify the relationship between hypertension and the prevalence of VPBs is thought to be useful to decrease the risk of cardiovascular diseases.

This paper reports a preliminary investigation in shift workers to clarify the differences in the prevalence of VPBs and supraventricular premature beats (SVPBs) between hypertensive (HT) and normotensive (NT) shift workers with the use of 24-hour Holter ECGs.

There were approximately 700 shift workers in the manufacturing company where we enrolled our subjects.

Shift workers were divided into HT and NT groups based on blood pressure measured three months before this survey. The HT group was defined as having a systolic pressure ≥160 mmHg or a diastolic pressure ≥95 mmHg, while the normotensive group had a systolic pressure <140 mmHg and a diastolic pressure <90 mmHg. Among the shift workers 12 males were identified as belonging to the HT group and all were selected for study. Twelve male NT workers who were matched for age (±3 years) and body mass index (BMI) (±2) with the HT group were selected for study. The BMI was calculated as weight in kilograms divided by the square of the height in meters. None of the 24 workers were receiving antihypertensive therapy.

Among the 24 shift workers, 20 shift workers (HT group, 9; NT group, 11) were fitted with 24-hour Holter ECG monitors. The remaining 4 had been transferred to another factory within the same company prior to the Holter ECG monitoring.

Table 2. Prevalence of supraventricular premature beat (SVPB)

		Hypertensive group		Normotensive group	
		number	%	number	%
Isolated SVPB	<10	5	56	9	82
	≥10	4	44	2	18
Couplet SVPB	0	7	78	9	82
	≥1	2	22	2	18
SVPB Run	0	6	67	11	100
	≥1	3	33	0	0

Shift workers engaged in a two × 8-hour shift system {day shift (8:00 to 16:00), night shift (20:00 to 4:00)} or a two × 12-hour shift system {day shift (10:00 to 22:00), night shift (22:00 to 10:00)}. Mean weekly working time was 32 hours for 8-hour shift workers and 35 hours for 12-hour shift workers.

On the day of ECG measurement, in the HT group, 6 workers were on 8-hour day shifts, and 3 workers were on 12-hour night shifts. In the NT group, 4 workers were on 12-hour day shifts and 7 workers were on 12-hour night shifts. Monitors were worn either the first or second day on day shifts or the second or third day on night shifts.

After receiving permission to conduct this study from the Ethics Committee at our institution, we recorded a 24-hour ECG for each of the 20 shift workers using a cardi memory RAC-102 (Nihon Kohden Co., Ltd., Japan). Data were then analyzed with an electrocardiograph analyzing system DSC-3100 (Nihon Kohden Co., Ltd., Japan) and comparisons were made between the prevalence and types of VPBs and SVPBs encountered among the 20 shift workers.

Statistical analysis of the differences in proportions was performed using Fisher's exact test.

Ages, systolic and diastolic blood pressure values, and BMIs of shift workers are shown in Table 1. Table 2 shows the prevalence of 3 types of SVPBs noted during 24-hour measurements. The number of isolated SVPBs detected ranged from 0–41 (mean=8) per person per 24 hours. We assigned 10 as the cut-off point, because the mean number of SVPBs was 8. The prevalence of SVPBs was 44% in the

Table 3. Prevalence of ventricular premature beat (VPB)

		Hypertensive group		Normotensive group	
		number	%	number	%
Isolated VPB	<10	7	78	8	73
	10–720	1	11	2	18
	≥720	1	11	1	9
Bigeminy VPB	<10	7	78	10	91
	≥10	2	22	1	9
Couplet VPB	0	8	89	11	100
	≥1	1	11	0	0
VPB Run	0	8	89	11	100
	≥1	1	11	0	0

HT group and 18% in the NT group ($P=0.34$). Two workers from each group experienced SVPB couplets. Three workers in the HT group had short runs of SVPBs, but comparison with the NT group showed no statistically significant difference.

The number and prevalence of VPBs occurring during the 24-hour monitoring period for both groups are shown in Table 3. Total isolated VPBs ranged from 0 to 1544 (mean=221) per person per 24 hours in the HT group and from 0 to 5274 (mean=522) per person per 24 hours in the NT group. The number of isolated VPBs in the vast majority of workers in both groups was under 10 per 24 hours. However, one worker from each group had ≥720 VPBs per 24 hours (Lown grade 2).

The prevalence of bigeminy was higher in the HT group than in the NT group, but not significantly so ($p=0.57$). A shift worker (HT group) had an episode of a short run (4 beats) of VPBs which was classified as Lown grade 4b.

In the present study, there are several confounding factors, such as shift hours (day or night shift), working hours (8 or 12 hours) on the measurement day and the length of duration having been engaged in shift work, which were not controlled. These factors were the limitations of this study.

Although we compared the differences of the prevalence of VPBs and SVPBs between the NT group and the HT group, we could not find statistically significant relationship between blood pressure and the prevalence of VPBs and SVPBs in this study. It was difficult to find the relationship between the prevalence of VPBs and blood pressure in shift workers in the present study, because the number of shift workers was 20. We managed to detect 2 shift workers with a high frequency of VPBs among all the subjects examined in the present study, with both experiencing more than 720 VPBs per 24 hour period.

A larger scale study is necessary to clarify the association between hypertension and the prevalence of VPBs and SVPBs.

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