Effect of Tobacco Smoking on the Heart Especially in Young Adults

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QRS axes of electrocardiograms were measured in 984 Japanese males who visited the Hokkaido University Hospital.

The average QRS axis in smokers was shifted to the left with age approximately 5 years earlier than in non-smokers. This seems to suggest that some individuals are "hypersensitive" to tobacco, among whom tobacco smoking advances the onset of atherosclerotic heart disease.

RECENTLY, a number of papers have disclosed the relationship between tobacco smoking and coronary arteriosclerosis¹⁻³.

However, there has been no report convincing that tobacco smoking in young healthy adults is a causative factor of coronary heart disease.

The present study was designed to investigate the chronic effect of tobacco smoking on the electrocardiographic findings, especially in healthy young adults. Statistical evidence of a left axis shift with age is regarded as a sign of clinically silent coronary atherosclerosis⁴. Therefore, observations were confined mainly to the axis difference between smokers and non-smokers.

METHODS

The QRS axes were measured in 984 Japanese

males who visited the second division of internal medicine at the Hokkaido University Hospital from January through to September in 1967, excluding the cases with complete bundle branch block and WPW syndrome. The majority of the 665 young men under 40 years of age revealed normal electrocardiographic findings, and there were only 15 cases (2.3%) showing ST-T abnormalities. The QRS axes were calculated by Einthoven's triangle method. (The axis of 0° represents a complete horizontal heart position, and the axis of +90° represents a complete vertical heart position.)

RESULTS

As shown in Table 1, the QRS axes were shifted to the left with age in both smokers and non-smokers. However, there was some difference of the mean axes between smokers and non-smokers. Under 24 years of age, there was no significant difference of the mean QRS

TABLE I AGE TREND OF LEFT AXIS SHIFT IN SMOKERS AND NON-SMOKERS

Age (yr.)	Smokers		Non-smokers		Significance levels of mean differences
	Number of subjects	Mean $\pm$ S.D.	Number of subjects	Mean $\pm$ S.D.	
15—19	32	69.1° $\pm$ 15.7°	39	68.7° $\pm$ 16.4°	—
(15—24)	(187)	(67.4° $\pm$ 20.3°)	(79)	(68.2° $\pm$ 16.4°)	(—)
20—29	264	65.6° $\pm$ 21.8°	66	67.7° $\pm$ 17.7°	—
(25—34)	(225)	(61.2° $\pm$ 24.8°)	(45)	(69.1° $\pm$ 17.1°)	(0.02—0.01)
30—39	220	57.8° $\pm$ 25.0°	44	68.2° $\pm$ 16.9°	0.01—0.001
(35—44)	(187)	(55.2° $\pm$ 25.6°)	(36)	(59.7° $\pm$ 24.0°)	(—)
40—49	151	48.7° $\pm$ 29.2°	23	41.3° $\pm$ 35.0°	—
50—84	116	48.4° $\pm$ 36.2°	31	39.4° $\pm$ 38.7°	—

S.D.: Standard Deviation

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axes between smokers and non-smokers, but it became evident gradually after 25 years of age. In the ages from 25 to 34 years, the mean axis of smokers ($61.2^\circ \pm 24.8^\circ$: mean $\pm$ standard deviation) showed a more pronounced shift to the left as compared with non-smokers ($69.1^\circ \pm 17.1^\circ$) and the difference was statistically significant at the 0.02 level. In the ages 30 to 39 years, the difference of the mean axes in both groups was most pronounced and was statistically significant at the 0.01 level (Smokers: $57.8^\circ \pm 25.0^\circ$, Non-smokers: $68.2^\circ \pm 16.9^\circ$). The mean QRS axis of smokers in the ages 30 to 39 years showed a higher shift to the left as compared against non-smokers of the ages 35 to 44 years ($59.7^\circ \pm 24.0^\circ$). Thus, for this age group, the tendency for the left axis shift was observed in smokers approximately 5 years earlier than in non-smokers.

As the age trend of the left axis shift leveled off after about 45 years of age in both smokers and non-smokers, the differences of the mean axis between the groups were small and were not statistically significant.

Fig. 1. Age Trend of Left Axis Shift in Smokers.

Figure 1 shows an early left axis shift of smokers.

Relationship between the left axis shift and the history of smoking habits (daily consumption of cigarettes and duration of smoking).

Figure 2 illustrates the relationship between

Fig. 2. Relationship between Left Axis Shift and Duration of Smoking in 22 to 25 Years of Age.

the left axis shift and the duration of smoking in the young age group from 22 to 25 years. The mean QRS axis was $67.1^\circ (\pm 18.9^\circ$: standard deviation) in 75 cases of short term smokers not exceeding 5 years, which was about the same as the mean axis of 27 non-smokers ($68.9^\circ \pm 18.3^\circ$) showed as a broken line in Figure 2. On the other hand, in 31 cases of long term smokers exceeding 5 years a considerable number of subjects revealed the left axis shift indicated by a diagonally striped area in Figure 2. The mean QRS axis of the long term smokers was $62.3^\circ (\pm 28.5^\circ)$. Consequently, a statistically significant difference in the distribution of the QRS axes was observed at the 0.05 level between the group of long term smokers and the group of short term smokers and non-smokers.

The result suggests that the effect of smoking is not yet apparent in short term smokers, and the tendency of the left axis shift becomes evident after a considerable length of smoking. Therefore, it seems apparent that smoking itself (or possibly something produced by smoking) leads to the early left axis shift as seen in smokers.

The relationship between the daily consumption of cigarettes and the left axis shift (under 34°) was studied in the age group of 30 to 39 years in which the difference of the mean axes was most evident between smokers and non-smokers. Ex-smokers and short term smokers not exceeding 5 years were excluded. The left axis shift under 34° was observed in only 1 (2.3 per cent) of the 44 non-smokers, while it was seen in 34 (17.4 per cent) of the 196 smokers. This difference in frequencies of the left axis shift between smokers and non-smokers may not be attributable to the difference in body constitution, since the distribution of relative body weight in smokers was about the same as that of non-smokers. The relative body weight was $104.34\% \pm 11.95\%$ (mean $\pm$ standard deviation) in smokers and $105.00\% \pm 11.49\%$ in the non-smokers. The relative body weight (R. B. W.) was calculated from the following equation,

$$\begin{aligned} \text{R.B.W.}(\%) &= \frac{\text{Body weight of the subject}}{\text{Standard body weight (kg)}} \times 100. \\ &= \frac{\text{Body weight of the subject}}{(\text{Height (cm)} - 100) \times 0.9} \times 100 \end{aligned}$$

Among the smokers in this age group, however, no constant relationship was noted between the daily consumption of cigarettes and the frequency of the left axis shift. The frequency of the left axis shift under 34° in subjects smoking 1-9, 10, 11-19, 20 and 21-70 cigarettes daily was 26.3 (5 of 19), 7.5 (3 of 40), 20.4 (10 of 49), 20.4 (12 of 59) and 13.8 per cent (4 out of 29 subjects), respectively. These results indicate that the frequency of the left axis shift in light smokers is high rather than in heavy smokers.

DISCUSSION

As previously mentioned, the trend of the

early left axis shift was clearly seen in the long term smokers; among the smokers, however, the trend was unrelated to the amount of cigarettes consumed. Moreover, as illustrated in Figure 2, the QRS axes of only a few smokers were shifted to the left by smoking, while the axes of the majority remained unchanged even by long term smoking. (Consequently, the mode of the axis in the long term smokers was $+75^\circ$ which is the same as in the non-smokers.) This seems to indicate that the distribution of the axes was shifted to the left by smoking not as a whole and could be divided into the following two groups; one is a small group showing a remarkable axis shift to the left, the other is a large group showing no significant axis shift. From these results, it is strongly suggested that the early left axis shift by smoking, rather than being related to the amount of tobacco consumed, may well be connected with "hypersensitivity" to tobacco.

The trend of the left axis shift by smoking seen in young men was similar to the age trend of the left axis shift as shown in Figure 1. The left shift with age is regarded as a sign of clinically latent coronary sclerosis as indicated by statistical studies⁴. Summing up these findings, it may be said that young healthy adults revealing a left axis shift attributable to "hypersensitivity" to tobacco smoking may suffer from coronary sclerosis in later life.

But also in non-smokers, the trend of the left axis shift was seen in a few of the elder subjects similar to that seen in smokers. This leads to the suggestion that a few individuals sensitive to tobacco smoking are present even in non-smokers. Therefore, the "hypersensitivity" to tobacco smoking may be considered to be unrelated to smoking habits and to be present preceding the habits.

In other words, a limited number of individuals sensitive to tobacco smoking exist in young healthy adults, who, irrespective of smoking, may suffer from coronary sclerosis in later life. However, the fact that the left axis shift is seen earlier in smokers than in non-smokers cannot be denied, and moreover there is a strong possibility that smokers suffer from coronary sclerosis earlier than non-smokers.

TABLE II INCIDENCE OF POSITIVE SKIN REACTIONS TO TOBACCO

	Under 40 Yrs. of Age	Over 40 Yrs. of Age
Control Group	12.5% (14/112)	4.1% (4/98)
Coronary Sclerosis or Idiopathic ECG Abnormality in Young Adults	80.0% (12/15)	35.3% (24/68)

In our previous paper⁵, a report was made on the possibility that subjects with positive skin reactions to tobacco in young healthy adults might suffer from the coronary sclerosis in later life. (Table 2 summarizes the results. The majority of the young adults who showed tobacco sensitivity, regardless of whether they smoked or not, showed no abnormal findings of the heart. However, among the tobacco sensitive subjects in high age levels, the cases without heart disease decreased whereas the cases with coronary sclerosis increased. Moreover, the majority of the subjects revealing signs of coronary sclerosis in comparatively young age levels showed positive skin reactions to tobacco. On the contrary, in the non-sensitive subjects to tobacco the incidence of coronary sclerosis was definitely lower than in the tobacco sensitive subjects.)

From these and our previous results, it was suggested that the "hypersensitivity" to tobacco smoking mentioned above may be readily detected by the tobacco skin test in healthy

young adults well in advance of the time when electrocardiographic abnormalities become evident.

SUMMARY

QRS axes of electrocardiograms were measured in 984 Japanese males who visited the Hokkaido University Hospital.

The average QRS axis in smokers was shifted to the left with age approximately 5 years earlier than in non-smokers. This seems to suggest that some individuals are "hypersensitive" to tobacco, among whom tobacco smoking advances the onset of atherosclerotic heart disease.

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