The effects of cigarette smoking on glycosylated hemoglobin in nondiabetic individuals

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Cigarette smoking has been shown to cause atherosclerotic heart disease in smokers. [1-3] The Surgeon General's report' has presented convincing evidence that smokers have a greater incidence of atherosclerotic heart disease than nonsmokers, whereas patients who have smoked but give up the habit have a decreasing rate of heart disease, thus indicating a direct causal relationship between cigarette smoking and atherosclerosis. The mechanism by which cigarette smoking causes atherosclerosis remains obscure, however.

Nicotine has been demonstrated to increase plasma levels of norepinephrine and epinephrine. [1,4-8] This increase in catecholamines is followed by an increase in heart rate and blood pressure as well as other changes attributed to increased adrenergic activity following cigarette smoking. None of these changes, however, can be directly linked to atherosclerosis in humans. Increases in plasma catecholamines have been known to cause increased hepatic glycolysis and gluconeogenesis and decreased pancreatic insulin secretion in humans, [9-11] leading to increased plasma glucose. One would expect, then, that cigarette smoking would lead to increased plasma glucose levels, especially when nicotine levels are high.

The literature on the effects of cigarette smoking on blood glucose is inconclusive. Sandberg et al [12] reported a transient increase of blood glucose levels from 4.21 mmol/L (75.8 mg/dl) to 4.93 mmol/L (88.8 mg/dl) within 30 minutes of smoking a cigarette. Similar results were reported by Bornemisza and Suciu, [13] by Murchison and Fyfe, [14] and by Haggard and Greenberg. [15] On the other hand, Cryer et al, [8] Rehder and Roth, [16] and Walsh et al [17] found no effect of smoking on blood glucose levels.

The effects of cigarette smoking on average blood glucose levels as measured by glycosylated hemoglobin have as yet received little attention. This study was done to assess the effects of smoking on plasma glucose by comparing the glycosylated hemoglobin levels of subjects who smoked one pack per day or more with those of nonsmokers.

METHODS

This study was part of a larger study of the relationship of glycosylated hemoglobin to risk factors for atherosclerotic heart disease. Subjects were recruited for cholesterol screening, and were generally unaware of the hypotheses of this aspect of the study.

Subjects were healthy, nondiabetic individuals (fasting blood glucose below 6.0 mmol/L, 108 mg/dL) who were on no medications known to affect blood glucose levels. Subjects ranged in age from 20 to 76 years, and represented thin and obese individuals in both the smoking and nonsmoking groups. They were recruited from the patient population of the local family practice center as well as from the professional staffs of the center and the local hospital. Smokers who averaged less than one pack per day were eliminated from the study. Nicotine content of cigarettes varies widely, and smokers differ widely in their smoking technique, making quantitation of the nicotine dose absorbed by an individual smoker from an individual cigarette difficult to estimate. No attempt was made to quantitate the level of smoking beyond the requirement of one pack per day or more. Fifteen smokers and 26 nonsmokers agreed to take part in the study. The average fasting blood glucose level of the smokers was slightly but not significantly lower than that of the nonsmokers, 4.14 mmol/L, SD = 1. 12 mmol/L, (74.5 mg/dl, SD = 20.1 mg/dl) vs 4.47 mmol/L, SD =.52 mmol/L, (80.5 mg/dl, SD = 9.3 mg.dl, t = 1.08, not significant).

Blood was drawn from each subject after an overnight fast, and was analyzed for glucose and glycosylated hemoglobin. Glucose was measured by the standard glucose oxidase method. Glycosylated hemoglobin was measured by the boronate gel affinity chromatography method using the Endocrine Science kit. [18, 19] This method has been shown to measure only the stable glycosylation product of hemoglobin; it is insensitive to the unstable Shiff base adduct, and thus is not affected by short-term changes in blood glucose. Glycosylated hemoglobin measured by this method has been shown to be a linear measure of average blood glucose over a wide range of values, with average glucose (mmol/L) = .886 X glycosylated hemoglobin 30. [18] This measure is more specific for average blood glucose than is the older hemoglobin A,, determination.

Data analysis was done using Student's t test.

RESULTS

The 15 smoking subjects had glycosylated hemoglobin levels ranging from 5.30% to 8.14% with an average of 6.82% (SD = 1.06%). The 26 nonsmoking subjects had glycosylated hemoglobin levels ranging from 4.80% to 6.8% with an average of 5.63% (SD = 0.49%). These averages are significantly different (t = 3.98, P<.001). These results indicate that the smokers have an average blood glucose that is 20% higher than that of the nonsmokers. The data are displayed in Figure 1 [omitted].

DISCUSSION

These results demonstrate a substantial and significant difference in average blood glucose levels between smokers and nonsmokers. The difference cannot be attributed to age differences. Normal subjects older than 60 years were reported to have an average glycosylated hemoglobin level of 5.7% (SD = .6%), which is only slightly higher than the 5.5% (SD = 0.5%) found for subjects younger than 60 years old. [18] Obesity is well known to impair glucose tolerance, and obese subjects were found in the smoking and the nonsmoking group. The highest glycosylated hemoglobin levels in the smoking group

were found in subjects who were not clinically obese, however, so obesity is unlikely to explain the differences found in glycosylated hemoglobin levels. The differences in glycosylated hemoglobin levels are probably not due to an increased frequency of borderline diabetes in the smoking group, as the smokers had, if anything, slightly lower fasting glucose levels than the nonsmokers.

Of the 15 smokers, 10 had glycosylated hemoglobin levels above 6.5%. This figure is in the range reported by the Endocrine Science group for patients with type II diabetes, [18] suggesting that these subjects have average plasma glucose levels that are high enough to place them at risk for the same complications as those with well-controlled diabetes, including atherosclerotic heart disease.

The data reported here are consistent with the report of Sheridan-Pereira et al, [20] who found increased hemoglobin A,, levels in pregnant smokers compared with those of nonsmokers. The present results are consistent also with the studies that found cigarette smoking to cause transient increases in blood glucose, [12-15] but do not support the negative results found by other authors. [8,16,11]

It is clear from the Framingham study [3] and many other studies that persons with diabetes have an increased risk of atherosclerotic heart disease compared with those who do not have diabetes. Since the majority of the smokers in this study had glycosylated hemoglobin levels in the diabetic range, the results presented here suggest that the elevations in average blood glucose in smokers compared with that in nonsmokers are adequate to explain some of the atherosclerotic heart disease known to be caused by cigarette smoking. Further study is needed to determine the clinical significance of this finding. Acknowledgment This research was supported by a Research Stimulation grant from Wayne State University.

References

1 Ball K, Turner R: Smoking and the heart: The basis for action. Lancet 1974; 2:822-826
2. Smoking and Health: A Report of the Surgeon General. Public Health Service. DHEW publication No. 79-50066. Government Printing Office, 1979
3. Dawber TR, The Framingham Study: The Epidemiology of Atherosclerotic Disease. Cambridge, Mass, Harvard University Press, 1980
4. Hill P, Wynder EL: Smoking and cardiovascular disease: Effect of nicotine on the serum epinephrine and corticoids. Am Heart J 1974; 87:491-496
5. Kershbaum A, Bellet S, Jimenez J, et al: Differences in effects of cigar and cigarette smoking on free fatty acid mobilization and catecholamine excretion. JAMA 1966; 195:1095-1098
6. Kershbaum A, Khorsandian R, Caplan RF, et al: The role of catecholamines in the free fatty acid response to cigarette smoking. Circulation 1963; 28:52-57
7. Winternitz W, Quillen BS: Acute hormonal response to cigarette smoking. J Clin Pharmacol 1977; 17:389-397

8. Cryer PE, Haymond MW, Santiago JV, Shah SD: Norepinephrine and epinephrine release and adrenergic mediation of smoking-associated hemodynamic and metabolic events. N Engl J Med 1976; 295:573-577
9. Bearn AG, Billing 6, Sherlock S: The effect of adrenaline and nor-adrenaline on hepatic blood flow and splanchnic carbohydrate metabolism in man. J Physiol (Lond) 1951; 115:430-441
10. Porte D, Graber AL, Kuzuya T, Williams RH: The effect of epinephrine on immunoreactive insulin levels in man. J Clin Invest 1966; 45:228-236
11. Steinberg D, Nestel PJ, Buskirk ER, Thompson RH: Calorigenic effect of norepinephrine correlated with plasma free fatty acid turnover and oxidation. J Clin Invest 1964; 43:167-176
12. Sanberg H, Roman L, Zavodnick J, Kupers N: The effect of smoking on serum somatotropin, immunoreactive insulin and blood glucose levels of young adult males. J Pharmacol Exp Ther 1973; 184:787-791
13. Bornemisza P, Suciu I: Effect of cigarette smoking on the blood glucose level in normals and diabetics. Rev Roum Med 1980; 16:353-356
14. Murchison L, Fyfe T: Effects of cigarette smoking on serum-lipids, blood-glucose and platelet adhesiveness. Lancet 1966; 2:182-184
15. Haggard HW, Greenberg LA: The effects of cigarette smoking upon the blood sugar. Science 1934; 69:165-166
16. Rehder K, Roth GM: Effect of smoking on the fasting blood sugar and pressor amines. Circulation 1959; 20:224-228
17. Walsh CH, Wright AD, Allbutt E, Pollock A: The effect of cigarette smoking on blood sugar, serum insulin and non-esterified fatty acids in diabetic and non-diabetic subjects. Diabetologica 1977; 13:491-494
18. Glycosylated Hemoglobin. Tarzana, Calif, Endocrine Science Products, 1984
19. Fairbanks VF, Zimmerman BR: Measurement of glycosylated hemoglobin by affinity chromatography. Mayo Clin Proc 1983; 58:770-773
20. Sheridan-Pereira M, Drury MI, Baumgart R, et al: Hemoglobin Al in diabetic pregnancy: An evaluation. Ir J Med Sci 1983; 152:261-267

Bibliography for: "The effects of cigarette smoking on glycosylated hemoglobin in nondiabetic individuals"

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