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Cigarette Smoking Behavior in Conjoined Twins

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A study of cigarette smoking was undertaken in a pair of craniopagus twins to determine how a transfer of products of smoking is occurring between the twins. Alternately and independently, one twin smoked a nicotine-free cigarette, then the second twin smoked a nicotine-containing cigarette. The procedure enabled the investigators to study the migration of nicotine and carbon monoxide from one twin to the other. Salivary determination provided a noninvasive method of measuring cross circulation in conjoined twins. Measurements of salivary nicotine, however, indicated that, although the nicotine levels rose following smoking, there was relatively little transfer from one twin to the other through the circulation.

Key words: Conjoined twins, Cigarette smoking, Saliva, Nicotine, Cross circulation

INTRODUCTION

In individuals who share a common circulation, drugs taken by one should influence the other. Smoking is considered by many investigators to be a form of drug-seeking behavior, and nicotine is considered the prime reinforcing agent among all the constituents of tobacco smoke [4,2]. Since parabiotic subjects, whether animal or human, offer the possibility of studying some of the humoral factors involved in smoking behavior, this study was designed to determine whether the nicotine transfer between members of a pair of conjoined twins was important in determining their smoking behavior. The intrapulmonary route of administering drugs is almost as fast as the intravenous route and is subject to less objection from sensitive or noncompliant subjects. Similarly, saliva provides a fluid vehicle for the measurement of chemicals, which reflects plasma drug levels in individuals who are reluctant to give blood.

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The frequency of birth of conjoined twins is varyingly estimated to be between 1:33,000 and 1:165,000 births (70% are female), and craniopagus twins (the rarest) reflect 1.7% of the total [1]. Very few survive to adulthood in their conjoined state. In the United States today there are only two pairs of such twins. Since one pair lives close to the investigators and consists of two heavy smokers, we felt it would be interesting to see how the smoking behavior of one of the pair would influence that of the other. The important factor in determining humoral interactions is the degree of cross circulation between the twins. We think this value could be obtained by a nuclear method with the use of isotopically tagged molecules injected into one twin and detected in the other, or radiologically by injecting various trace media into one twin and attempting to detect them in the other. However, the twins lead a semireclusive life to shield them from possible exploitation and curiosity. Accessibility is therefore limited, and the nature of the experiments and investigations is also limited to noninvasive procedures to determine their circulatory status.

The twins consented to act as subjects in our laboratory, with the restriction that no invasive procedures, not even venipuncture, would be used, and that no psychological questionnaires would be employed. Despite these limitations we felt that they would offer us a unique opportunity to observe the interactions that they demonstrated during smoking behavior.

CASE REPORT

The twins are 32-year-old female craniopagus twins. Apart from the juncture at the top of their heads they appear to be in good physical condition. They began smoking when they were 21 years of age, and they smoke about a pack of cigarettes per day. They consider smoking important during the day, since they are largely homebound and have a restricted range of activities that includes watching television. They agreed to be interviewed and to follow our instructions about smoking and consented to give us samples of saliva and carbon monoxide.

One of the main purposes of this study was to determine indirectly or by means of noninvasive procedures just how much influence the sharing of a portion of their circulation might have on the interaction of smoking.

Method of Procedure

The procedure was designed to measure the influence of smoking in one twin upon the other. We were constrained to working without needles and without questionnaires; smoke was self-administered. The nicotine-free cigarettes were FREE, a commercial brand name made from the stems and husks of cocoa, containing no nicotine. Benson and Hedges, the cigarettes ordinarily smoked by the twins, deliver 1.1 mg nicotine and 17 mg tar.

The twins came to the laboratory at noon and were asked not to smoke overnight before coming. They assured us that they had complied. The session took place between 2:00 PM and 4:00 PM. Food was provided to determine whether postprandial craving for a cigarette could be induced. At approximately 2:30 PM, twin B was given a snack of dry toast and Brim decaffeinated coffee. At 2:50 PM twin A smoked a FREE cigarette; at 3:00 PM twin A was given a snack also consisting of dry toast and Brim decaffeinated coffee; at 3:07 PM twin B smoked a Benson and Hedges; at 3:37 PM twin A smoked a Benson and Hedges. Craving measures of smoking and hunger were taken at seven intervals during

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the study. The twins turned a knob on a potentiometer dial divided into ranges marked "none," "a little," "moderate," "quite a bit," and "extreme"; the readings were converted into arbitrary units ranging from 1 to 10.

Carbon monoxide measures were taken at the beginning of the study and following each cigarette smoked by collecting a sample of alveolar air in a plastic sample bag (manufactured by Energetics Science, Inc., Elmsford, New York) and measuring the CO content by means of an Ecolyzer.

Saliva was collected after each smoking period so that measurements of nicotine could be made. Salivary pH was also measured, since it would affect the charge of the nicotine molecule and hence its ability to pass from the blood into saliva. The more alkaline the saliva, the higher would be the ratio of nicotine concentration in blood to that in saliva. Salivation was stimulated by having the subject suck on a sugar cube, and was collected by having the subject salivate into a cup.

RESULTS AND DISCUSSIONS

Cigarette craving of either twin was unaffected by smoking either a FREE or a Benson and Hedges and by the administration of food. Ratings remained at 4. After twin A smoked a Benson and Hedges, the craving of twin B went up from a 4 to a 5, while the craving of twin A decreased from a 4 to a 3.

Carbon monoxide measurements, which were taken four times during the session, were probably not reliable, since the twins did not hold their breaths properly. These measures showed very little change from baseline.

Subjects were interviewed by the experimenters during the course of the study in order to determine what types of smokers they were. However, they answered "yes" to all the questions, which would indicate that they were smoking for stimulation, relaxation, tension reduction, craving, habit, or sensorimotor manipulation [3].

Salivary Nicotine Measurements

The most interesting results come from the saliva studies. After twin A smoked a nicotine-free cigarette, the level of nicotine in twin A's saliva was only 4.6 ng/ml (see Figure). The fact that twin B's saliva at this time showed a level of 23.3 ng/ml indicates that she must have been not as compliant as desired and probably smoked a cigarette at some recent time. However, the fact that nicotine levels of the twins were so disparate is evidence for minimal cross circulation if saliva accurately reflects the blood levels.

The second measurement was taken after twin B smoked a tobacco cigarette and a substantial rise was seen in twin B's saliva, as expected (52.2 ng/ml). However, there was only a very small rise in twin A's saliva (0.3 ng/ml), which is further evidence for little cross circulation.

In the third portion of the session after twin A smoked a tobacco cigarette, her nicotine level also rose markedly to 107 ng/ml, but by this time twin B's level had fallen to only 27.9 ng/ml. Again, this result is consistent with a finding of poor cross circulation.

Twin B had a consistently higher salivary pH than twin A at all time intervals. Smoking appeared to have no discernible effect on salivary pH, which actually remained within a mild alkaline range, 7.1 to 8.0 during the entire session, which eliminates pH as an important source of variability.

It is conceivable that some of the nicotine could also have derived from passive smoking, since the twins are in such close proximity to one another. However, this would

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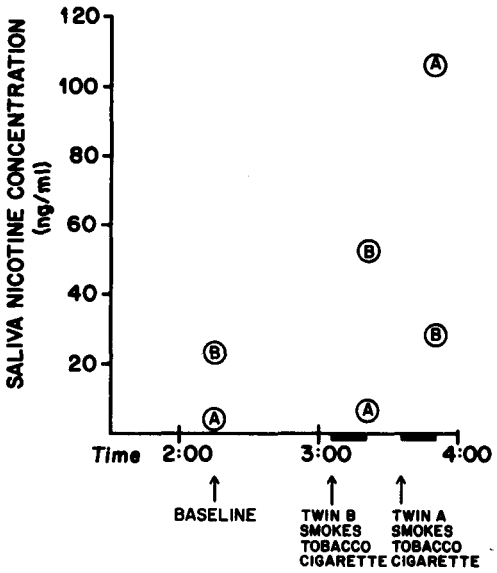

Fig. 1. Saliva nicotine concentrations in twins A and B after smoking a cigarette delivering nicotine.

have led to an increased level of nicotine in the nonsmoking twin when the other was given a cigarette. This increase was not observed.

There were two routes for chemicals from tobacco smoke to get from one twin to the other—one was through the air, as with passive smoking or breathing, and the other was through the shared circulation. After twin A smoked a nicotine-containing cigarette, her nicotine level increased dramatically, reflecting the 30-minute plasma half-life of nicotine. Thus the nicotine levels reflect the smoking behavior of the twins fairly accurately, but indicate that there was little or no cross circulation occuring between the twins. This result agrees with the testimony of the twins that they smoke independently of one another, and that a cigarette smoked by one twin gave no satisfaction to the other twin.

The twins said that they would and could smoke independently of one another, and that they received no internal subjective signals that one was smoking when the other was not. Rather, they could tell by watching or by smelling the smoke. As further evidence of relatively independent circulations, they reported that on one occasion one twin had an infected finger resulting in a fever, while the other felt perfectly well. Nevertheless, the doctor prescribed antibiotics for both.

These results also illustrate that noninvasive measures could qualitatively demonstrate the extent of cross circulation in conjoined twins. In this case, despite the craniopagus condition there was evidently very little cross circulation. It would be highly desirable to be able to check this with angiograms, or noninvasive measures such as ultrasound or nuclear magnetic resonance, or CAT scanning. The twins will not fit in the conventional CAT scanners, and ordinary x-rays without the injection of radiopaque materials would not demonstrate the circulation.

The precise amount of nicotine delivered by a cigarette cannot be accurately estimated, since puffing patterns may produce wide variations in blood levels of nicotine [5]. However, saliva fairly accurately reflects blood levels of a variety of drugs, including

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nicotine. This study indicates that these conjoined twins may have relatively little cross circulation (although they must have some), and therefore may not be suitable subjects for parabiotic studies involving the cross perfusion of substances.

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