Effect of Sucrose on Hyperkinetic Children

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ABSTRACT. A hyperkinetic boy and his mother were found, by blind tests, to be hypersensitive to sucrose, with manifestations of irritability, hyperactivity, and headache. Neither glucose, lactose, or saccharin produced any behavioral changes. To ascertain whether this was common in those with hypersensitivity to sucrose, 50 hyperkinetic children, whose mothers had volunteered that they "knew" or were "sure" that their hyperactivity and general behavior were much worse when they had eaten foods containing sugar (sucrose), were tested in a blind experiment with a challenge dose of a glass of lemonade containing 75 g of sucrose compared with lemonade sweetened with saccharin; this was done three times. No differences could be found in their behavior after ingesting sucrose compared with saccharin. Hypersensitivity to sucrose can lead to adverse behavioral changes, but this hypersensitivity appears to be an uncommon condition. If suspected it can be tested for very simply. *Pediatrics* 1984;74:876–878; sucrose, hyperkinetic syndrome, attention deficit disorder, minimal brain dysfunction, diet and behavior.

To many laypersons, "sugar," meaning refined sucrose, has a bad connotation. In the media,[1] it has frequently been given the label "junk food," and this is reinforced by some physicians[2] who attribute to refined sucrose many bodily disorders, especially those occurring in children. (The term "junk food" is meaningless, and should never be used in scientific literature without quotation marks. "Food" is defined (Webster's Third New International Dictionary) as "material consisting of carbohydrates, fats, proteins, and supplementary substances (as minerals, vitamins) that is taken or absorbed into the body of an organism in order to sustain growth, repair, and all vital processes and to furnish energy for all activity ...." "Junk" is defined as "... something without intrinsic value; trash." Sucrose is a carbohydrate that furnishes energy, so is by definition food. What is confused by many is the difference between food and "diet," the latter defined as "habitual nourishment." What human beings require is an adequate and balanced diet. Because various compounds essential for life have some finite storage life in the body, on the order of days or weeks (excluding oxygen), it is not necessary that every mouthful of food be a perfectly balanced aliquot of a good diet. "Habitual nourishment" may in some cases not provide the substances needed for vital processes. One would label such a diet as poor or inadequate or defective in nutrition. But to label a food as poor or inadequate or not nutritious makes no sense.)

At the present time, sucrose is definitely implicated in one disease process—dental caries.[3] Crook[4,5] is convinced that sucrose "is a leading cause of hyperactivity ..." but he presents only anecdotal data that fail to provide any evidence of how frequently this occurs. He claims that one of the children he treated with diet became a "different child"; when the child ate sugar-containing foods, his symptoms reappeared in five minutes and lasted some four hours. Sucrose also causes gastrointestinal symptoms in those who lack the enzyme sucrase,[6] but because hyperactive children do not typically have gastrointestinal symptoms, sucrase deficiency cannot be relevant to the hyperkinetic syndrome.

Despite the lack of data, the notion that sucrose is harmful is so widespread that patients bring this up frequently with their physicians. Health food stores promote fructose and honey as "natural" sweeteners, even though honey usually contains some sucrose.[7] With parents of hyperkinetic children, the belief that sucrose is harmful, worsening their child's symptoms, or even causing them de novo, is quite common in my experience. Many parents state that when their child eats sugar-containing foods, he or she becomes more out of control. If these beliefs have, indeed, some validity, then careful monitoring of sucrose intake should be part of the treatment of the hyperkinetic syndrome.

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If they have no validity, then thousands of children can be liberated from onerous diets that serve no purpose. This study concerns itself with the relationship between sucrose intake and behavioral changes in hyperkinetic children.

Two years ago, I treated a boy with typical symptoms of the hyperkinetic syndrome, whose mother claimed that both she and her son reacted negatively to table sugar. The patient was a 5-year-old boy who was irritable, hyperactive, and distractible; he had a short attention span, visual and auditory perceptual deficits, and nightly enuresis. His mother endeavored to keep him on a diet as free of sugar as possible. He was first given a trial regimen of imipramine and then methylphenidate. The imipramine made his behavior even worse, but the methylphenidate helped with his behavior and attention span, and partly alleviated the enuresis. As a blind experiment, the patient was given, on several occasions, a glass of lemonade to drink; the lemonade was variously made with sucrose, glucose, lactose, or saccharin. In three of three trials, he reacted to the lemonade with sucrose: he became easily frustrated, hyperactive, and difficult to control; this behavior started within five or ten minutes and lasted about four hours. The saccharin and the other sugars had no perceptible effect. Each challenge of sucrose was approximately 20 g.

The patient's mother was tested with the same experiment. She became irritable and developed a headache in approximately 15 minutes, and she felt unwell for the rest of the day, but only with the lemonade made with sucrose. In another experiment, she was given decaffeinated coffee sweetened with either 10 g of sugar or with saccharin. Again, she reacted only to the coffee sweetened with sucrose. It was hoped that she and her son could be further tested to try to ascertain the mechanism of the hypersensitivity to sucrose, but they moved away and follow-up was not possible.

In order to elucidate what role sucrose might play in other children with the hyperkinetic syndrome, a double-blind study was undertaken to compare the effect of a large challenge dose of sucrose with saccharin in children who were hyperkinetic. Only those children whose mother had volunteered that she "knew" or was "sure" that her child was "allergic" to table sugar were included in this study, so there is a strong bias for a positive finding in this sample selection.

MATERIALS AND METHODS

Each year, I see about 150 children with the hyperkinetic syndrome. For the past 2 years, whenever a patient's mother made a statement that she was convinced that sugar caused her child's symptoms or made them worse, she was invited to participate in a blind study comparing the effects of lemonade made with sucrose *v* lemonade made with saccharin. The first 50 mothers who gave informed consent and were available for follow-up provided the data for this study.

One quart of lemonade was prepared using 225 g, or about 1 cup, of table sugar, 90 mL of thawed frozen lemon juice, and water to fill a one-quart jar. A second jar contained 90 mL of lemon juice and enough saccharin to approximate the same sweetness. The jars were given a code that was not broken until after the experiment had been reported. The mother was asked to give a serving of one third of one of the jars to the child at a time when the child could be observed for several hours and to rate his or her behavior on a scale from −5 to +5, with zero indicating no change from usual behavior, −5 indicating much worse, and +5 indicating much better, with numbers in between for intermediate ratings. This was to be repeated in any order until both quarts were consumed. Each one-third quart provided either 75 or 0 g of sucrose, and there were three replications comparing sucrose with saccharin.

Patients were 36 boys and 14 girls ranging in age from 5 to 17 years (average age 8.6 years). In 49 children, medications typically prescribed for the hyperkinetic syndrome (methylphenidate, dextroamphetamine, or pemoline) were later tried and found successful, confirming the diagnosis. One patient dropped out of the study before medication could be tried.

RESULTS

Not one of the 50 children showed any consistent response to the sucrose. A typical comment made by the child's mother was: "It seemed to depend on other factors how he behaved rather than which jar I used. I couldn't see any consistent pattern." Some mothers stated that their child could tell the difference between sugar and saccharin by the taste, but apparently this did not bias the results. The ratings averaged the same for both sucrose and saccharin: −0.32 and −0.33, respectively (very slightly worse behavior for each).

COMMENT

The mechanism of sucrose hypersensitivity is not known. Because sucrose is a small molecule, an immunologic mechanism is not possible.[8] Wurtman[9] has shown that carbohydrate-rich meals increase brain serotonin levels in rats and that in man tryptophan, which is known to drive serotonin, causes lethargy. But it is likely that increasing brain

serotonin should improve, not exacerbate, hyperkinetic behavior, especially because imipramine, which increases brain synaptic concentrations of serotonin,[10] helps many hyperkinetic children.

CONCLUSIONS

A hypersensitivity to sucrose can exist, and it can lead to behavioral deterioration, as evidenced by the first family tested. Because none of the other children showed any differential response to a large challenge dose of sucrose *v* saccharin, it must be concluded that sucrose does not commonly affect hyperkinetic children adversely. If there is some compelling reason to suspect sucrose hypersensitivity, a simple blind experiment can enable this determination.

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Under 1 year	3,614,000
1 year	3,704,000
2 years	3,629,000
3 years	3,533,692
4 years	3,269,557
5 years	3,223,816
6 years	3,179,441
7 years	3,141,748
8 years	3,162,691
9 years	3,109,095
10 years	3,273,052
11 years	3,394,998
12 years	3,760,120
13 years	3,716,530
14 years	3,580,644
15 years	3,518,982
16 years	3,643,189
17 years	3,782,784
18 years	4,059,898
19 years	4,180,875
20 years	4,223,848
21 years	4,251,779
22 years	4,451,724

(First three lines as reported by National Center for Health Statistics; other figures from 1980 Census)

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