AGGRESSIVE BEHAVIOR
Volume 12, pages 303–310

Insulin Secretion During the Glucose Tolerance Test Among Habitually Violent and Impulsive Offenders

Matti Virkkunen

Psychiatric Clinic, Helsinki University Central Hospital, Helsinki, Finland

Male habitually violent and impulsive offenders were studied by means of the glucose tolerance tests (GTTs) and insulin measurements. Both in intermittent explosive disorder and in violent antisocial personality, there was a tendency for there to be reactive hypoglycemia. There was a more rapid decline of glucose from hyperglycemia and more rapid return from hypoglycemia to the original basal values in intermittent explosive disorder than in violent antisocial personality. Consistent with this, the enhanced insulin secretion started rapidly but lasted a short time in intermittent explosive disorder.

Key words: insulin, reactive hypoglycemia, habitual violence, impulsivity, antisocial personality, intermittent explosive disorder

INTRODUCTION

For several decades, there has been some evidence that hypoglycemia could in some way be connected with criminal and, especially, violent behavior [Hill and Sargant, 1943; Wilder, 1947; Bovill, 1973; Bolton, 1973,1976; Yarura-Tobias and Neziroglu, 1975,1981; Moyer, 1976; Neziroglu, 1979]. Irritability and aggression have also been described in patients suffering from labile diabetes because of hypoglycemic aspects [Swift et al, 1967; Tattersal, 1981; Wilkinson, 1981; Surridge et al, 1984]. Benton et al [1982] have found that even mild hypoglycemia in the glucose tolerance test correlates with the valid psychological questionnaire measures of aggression. Dietary differences between a group of chronic offenders and a group of behaviorally disordered students have also been reported [Schauss and Simonsen, 1979], and there have been preliminary findings that antisocial and violent acts among juvenile delinquents living in detention homes can be reduced by lowering the daily sucrose intake [Schoenthaler, 1982].

Received for publication November 9, 1984; revision accepted November 21, 1984.

Address reprint requests to Dr. Matti Virkkunen, Psychiatric Clinic, Helsinki University Central Hospital, Lapinlahdentie 00180 Helsinki 18, Finland.

Tests using DSM-III criteria [American Psychiatric Association, 1980] have now clearly shown a reactive hypoglycemic tendency during the glucose tolerance test (GTT) in violent antisocial personality and in intermittent explosive disorder [Virkkunen, 1982,1983a; Virkkunen and Huttunen, 1982]. Impulsive, explosive arsonists were also found to have a reactive hypoglycemic tendency in GTT [Virkkunen, 1984]. Preliminarily, this tendency has been found to be connected with an enhanced free insulin secretion in violent antisocial personality [Virkkunen, 1983a].

In this study, the purpose was to check more exactly the glucose and insulin secretions in violent antisocial personality and in intermittent explosive disorder. In the earlier studies, it was found that the reactive hypoglycemic tendency in intermittent explosive disorder usually continues only a short time; but in violent antisocial personality, this tendency lasts a longer time [Virkkunen, 1982; Virkkunen and Huttunen, 1982]. So it was thought that there must also be differences in free insulin secretion profiles.

METHOD

Subjects

In the Mental Examination Department of the Psychiatric Clinic of the Helsinki University Central Hospital, 33 successive male habitually violent and impulsive offenders were investigated. Of these, 13 fulfilled the criteria for an antisocial personality (Group A) in DSM-III and had at the same time the habitually violent and impulsive tendency usually exhibited under the influence of alcohol. This antisocial personality had been preceded by undersocialized aggressive conduct disorder in adolescence. Altogether, 20 persons had an intermittent explosive disorder with the same kind of tendency (Group B). They did not fulfill enough criteria for antisocial personality, especially in childhood. Of these, five were impulsive, explosive arsonists whose violent crimes so far had been only arson, although they also had, at least to some extent, the same kind of tendency under the influence of alcohol in interpersonal relations. Those who were retarded (IQ under 68) or had a chromosome abnormality (XYY or XXY) were not included. Neither were those who had an antisocial personality but not the habitually violent and impulsive tendency (as is usually the case with habitual thiefs), nor were any psychotics included. All habitually violent and impulsive offenders fulfilled the criteria for alcohol abuse in DSM-III, but nobody had a liver disease according to the medical examinations of the internist and the routine laboratory tests (SGOT and SGPT). The offenders had been in prison and so without alcohol approximately five months prior to the GTTs. All offenders were hospitalized for at least three days before the study, and they were given a diet with a minimum of 48–55 percent of calories as carbohydrates, which is a standard in the University Central Hospital.

In addition, a comparison group was composed of 13 healthy men from the personnel of the psychiatric clinic of Helsinki University Central Hospital (Group C). They were matched as closely as possible for age and relative body weight (RBW) with the habitually violent and impulsive offender groups (Table I). Nobody in the comparison group had any kind of aggression or alcohol abuse problems. They were advised to keep their normal diet during the three days preceding the experiment.

TABLE I. Background Factors of Habitually Violent Offenders and Psychiatric Personnel

Background Factor	Mean ± SD			P
	GroupA[a]	Group B[b]	Group C[c]	
Age (years)	26.1 ± 7.3	25.5 ± 8.9	27.4 ± 8.7	NS
Weight (kg)	72.4 ± 8.2	71.6 ± 14.8	72.8 ± 7.5	NS
RBW % (relative body weight)	92.1 ± 9.2	90.7 ± 18.2	93.4 ± 8.6	NS
Verbal IQ[d]	103.7 ± 14.4	88.1 ± 7.2	—	< 0.01
Performance IQ[d]	103.8 ± 16.1	92.9 ± 16.2	—	< 0.05
Total IQ[d]	103.9 ± 15.2	89.4 ± 9.8	—	< 0.01
Marks for attention in 10-grade system in the first year of school	7.9 ± 1.0	6.2 ± 0.4	9.4 ± 0.7	< 0.05
Marks for attention at the end of school in late adolescence	7.9 ± 1.0	6.0 ± 0.7	9.5 ± 0.5	< 0.05

[a]Group A = Habitually violent offenders with intermittent explosive disorder.
[b]Group B = Antisocial personality with habitually violent tendency.
[c]Group C = Psychiatric male personnel.
[d]In IQs, no multiple comparisons were made.

Performance of the GTT

After the initial screening, all the participants underwent a five-hour GTT with free insulin measurements. It was preceded by an overnight fast of at least 12 h, but in no case more than 16 h. Stress was avoided the night before and during the test. No other examinations were done on the same day. No medicines were taken during the test or during the three previous days.

On the morning of the examination, after fasting blood samples had been taken, all the participants were given glucose (Glycodyn®) 1 g/kg (4 ml/kg) body weight, which was taken orally as quickly as possible. Blood samples were then collected after ¼, ½, 1, 1½, 2, 3, 4, and 5 h for blood glucose and insulin measurements. The blood glucose was measured by enzymatic method [Hjelm, 1966], and the plasma free insulin by radioimmunoassay technique of Pharmacia's Phadebas® Insulin Test [Wide and Porath, 1966]. The last insulin sample was taken after 3 h, as the basal level had then been reached.

Statistics

The analysis of variance (ANOVA) was carried out in the University of Helsinki Computing Centre. If significant interactions were identified, then the multiple comparison procedure of Gabriel [1978] was applied. A repeated measures analysis of variance and Student's t test were also used.

Background Factors

In the background factors (Table I), Group A differed from Group B in IQs. In marks for attention in the 10-grade system in school, both in the first year ($F = 51.21$,

df 2 and 43, $P < 0.05$) and at the end of school in late adolescence ($F = 58.81$, df 2 and 43, $P < 0.05$), there were significant group effects; these were attributable, according to a Gabriel's post hoc test, mainly to a difference between Group C and other groups. So, in both violent and impulsive offender groups, there had been attention deficit problems, although these were seen more clearly in Group B.

All violent and impulsive crimes had been committed under the influence of alcohol. The habitually violent and impulsive offenders had had little or no appetite during the drinking bouts, which had lasted on average for 7.5 ± 2.3 h before the violent crimes.

RESULTS

Because the mean ± SD basal value of glucose in the control group (Group C) (4.5 ± 0.5 mmol/l) was different from the intermittent explosive disorder (Group A) 4.1 ± 0.3 mmol/l) or the antisocial personality (Group B) (4.2 ± 0.4 mmol/l) ($F = 4.27$, df 2 and 43, $P < 0.05$) both in glucose and in insulin values, only Δ values (values − basal values) were compared.

An analysis of variance (ANOVA) of the mean Δ 60-minute glucose value (Table II) demonstrated a significant group effect ($F = 7.91$ df 2 and 43, $P < 0.05$) attributable, according to a Gabriel's post hoc test, to more rapid decline of glucose in Group A than Group B. The Δ 180-minute value also demonstrated a significant group effect ($F = 5.75$, df 2 and 43, $P < 0.05$) attributable to a severe reactive hypoglycemia both in Group A and in Group B. In Δ 300-minute value, there was also a significant group effect ($F = 7.41$, df 2 and 43, $P < 0.05$) attributable to a rapid return in Group A from reactive hypoglycemia. In Δ blood glucose nadir there was a group effect ($F = 4.34$, df 2 and 43, $P < 0.05$) that was however, attributable mainly to a difference between Group A and Group C.

In Δ insulin values, conforming to the above findings, there were already differences in 15-minute value (F 4.36, df 2 and 43, $P < 0.05$) because of enhanced secretion in Group A. Also conforming to the above findings, this insulin secretion ended in this group more rapidly than in the other groups (F 3.58, df 2 and 43, $P < 0.05$).

In glucose values, repeated measures ANOVA revealed significant main effect of time ($F = 58.81$, df 7 and 301, $P < 0.001$) and group × time interaction ($F = 4.14$, df 14 and 301, $P < 0.001$). In insulin values, repeated measures ANOVA revealed significant main effect of time ($F = 34.88$, df 5 and 215, $P < 0.001$), groups ($F = 4.06$, df 2 and 43, $P = .024$), and group × time interaction ($F = 4.51$, df 10 and 215, $P < 0.001$).

Among the five impulsive, explosive arsonists, the decline of blood glucose seemed to be less rapid than among other A cases, but the comparisons by t tests were not significant. In blood glucose nadir (−1.26 ± 0.50 mmol/l/−1.42 ± 0.58 mmol/l) and insulin peak value (67.4 ± 32.3 mU/l/65.9 ± 1.5 mU/l), there were also no differences.

The cholesterol level seemed to be low among habitually violent and impulsive offenders with enhanced insulin secretion especially in lower age groups ($r = 0.318$, $N = 33$, $P < 0.05$).

TABLE II. Glucose Tolerance Test Results and the Insulin Secretion During the Test Among Habitually Violent Offenders and Psychiatric Personnel*

	Group A[a]	Group B[b]	Group C[c]	F-value	F-significance	Gabriel's test A/B	Gabriel's test A/C	Gabriel's test B/C
Δ Glucose values (mmol/l)								
15 minutes	1.8 ± 0.6	1.6 ± 1.0	1.8 ± 0.7	0.24	NS	NS	NS	NS
30 minutes	2.2 ± 1.1	3.2 ± 1.7	2.9 ± 1.4	2.46	0.097	NS	NS	NS
60 minutes	0.7 ± 1.5	3.3 ± 2.1	2.2 ± 2.0	7.91	0.001	< 0.05	NS	NS
90 minutes	0.6 ± 1.5	1.5 ± 2.3	1.3 ± 1.8	1.12	0.335	NS	NS	NS
120 minutes	−0.1 ± 1.1	0.4 ± 1.2	0.6 ± 1.6	1.22	0.305	NS	NS	NS
180 minutes	−0.9 ± 0.6	−1.0 ± 0.7	0.1 ± 1.2	5.75	0.006	NS	< 0.05	< 0.05
240 minutes	−0.3 ± 0.3	−0.5 ± 0.3	−0.4 ± 0.3	2.05	0.142	NS	NS	NS
300 minutes	0.1 ± 0.3	−0.3 ± 0.3	−0.1 ± 0.4	7.41	0.002	< 0.05	NS	NS
Δ Blood glucose nadir (mmol/l)	−1.4 ± 0.6	−1.4 ± 0.3	−0.9 ± 0.5	4.34	0.019	NS	< 0.05	NS
Δ Insulin values (mU/l)								
15 minutes	43.8 ± 33.3	24.1 ± 15.4	20.5 ± 13.5	4.36	0.019	NS	< 0.05	NS
30 minutes	62.1 ± 47.2	44.6 ± 21.5	31.8 ± 20.3	3.07	0.057	NS	NS	NS
60 minutes	48.1 ± 48.8	54.3 ± 24.7	26.3 ± 23.0	2.10	0.135	NS	NS	NS
90 minutes	30.9 ± 28.8	41.8 ± 21.5	20.7 ± 10.7	2.76	0.075	NS	NS	NS
120 minutes	18.6 ± 25.8	27.9 ± 21.5	19.1 ± 15.7	0.79	0.462	NS	NS	NS
180 minutes	−1.5 ± 5.0	2.5 ± 5.7	4.0 ± 7.7	3.58	0.036	NS	< 0.05	NS
◦ Insulin peak value (mU/l)	66.3 ± 46.6	60.0 ± 22.7	41.9 ± 19.3	1.98	0.151	NS	NS	NS

*Mean ± SD.
[a]Group A = Habitually violent offenders with intermittent explosive disorder.
[b]Group B = Antisocial personality with habitually violent tendency.
[c]Group C = Psychiatric male personnel.

DISCUSSION

The results correspond well with the earlier findings that in intermittent explosive disorder, the situation in the glucose tolerance test and in the free insulin secretions differ from that in violent antisocial personality and from normal male controls. The biological results also suit the clinical picture in this disorder [American Psychiatric Association, 1980].

There have also been findings indicating that many kinds of habitually violent and impulsive offenders have low brain serotonin metabolism (low CSF 5-HIAA) [Brown et al, 1979,1982; Bioulac et al, 1980; Brown and Goodwin, 1984]. Using DSM-III criteria, this has now been found to be true among impulsive murderers and attempted murderers, both those with intermittent explosive disorder and those with violent antisocial personality [Linnoila et al, 1983]. Similar findings have been found in Sweden among those who have impulsively killed their sexual partner [Lidberg et al, 1985] or their own children [Lidberg et al, 1984]. At the same time, it is known that there is a connection between serotonin metabolism and insulin secretion [Fernström and Wurtman, 1971,1972]. In healthy, nonobese, fasting men, glucose intake will, because of insulin, affect the ratio of plasma tryptophan to other plasma large neutral amino acids, which is thought to be important in brain serotonin synthesis [Martin-Du Pan et al, 1982]. Dietary carbohydrates cause only small decreases in total tryptophan (ie free plus albumin-bond), which results from tryptophan's property, unique among amino acids, of traveling in the circulation largely bound to albumin [McMenamy and Oncley, 1958]. Nonesterified fatty acids (NEFA), however, also share these albumin binding sites with tryptophan, and fasting increases NEFA, thereby causing increased levels of free tryptophan [Knott and Curzon, 1972; Knott et al, 1973]. Fasting was typical of habitually violent and impulsive offenders in this study during the drinking period before the violent crimes.

There are also other facts why fatty acid metabolism can be connected with the abnormal glucose-insulin findings among habitually violent and impulsive offenders. Of polyunsaturated fatty acids, the dihomogamma-linolenic, and the arachidonic acid metabolites, prostaglandins [Robertson, 1983; Turk et al, 1984] and, especially, leukotrienes [Pek and Walsh, 1984] have a clear effect on insulin secretion. These acids are formed from the gamma-linolenic acid, which clearly lowers plasma cholesterol levels [Horrobin and Manku, 1983]. Low cholesterol levels have been found to be typical among habitually violent and impulsive offenders, especially in younger age groups [Virkkunen, 1979,1983b; Virkkunen and Penttinen, 1984]; and low cholesterol level has been found to correlate with enhanced insulin secretion among habitually violent, impulsive offenders [Virkkunen, 1983a], as is also the case in this study. On the other hand, the formation of gamma-linolenic acid is increased by insulin [Brenner, 1981]. Thus, the connections with glucose, low brain serotonin, and cholesterol/polyunsaturated fatty acid metabolism need further studies.

ACKNOWLEDGMENTS

The author acknowledges the assistance of Markku Javanainen from the University of Helsinki Computing Centre in the statistical analysis.

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